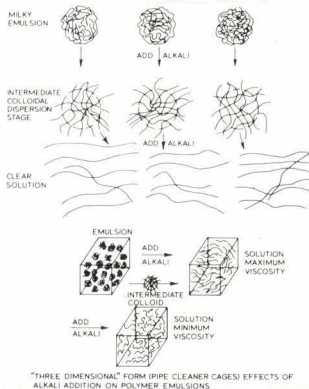
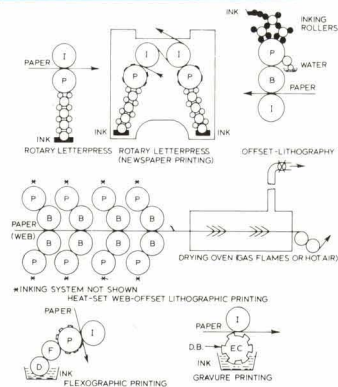


J
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C
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A

Advances in the technology of water based



inks for the printing and packaging industries

Also in this issue

- Novel corrosion inhibitors
- ✉ A letter on Wet Adhesion

- Indexes for Volume 68
- Professional grade register

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Vol. 68 No. 12
1985



CHLORINATED RUBBER TYPE

CHLORINATED POLYETHYLENE
 CHLORINATED POLYPROPYLENE
 CHLORINATED RUBBERS
 etc.

APPLICATION

- Anticorrosive coatings
- Road marking paints
- Gravure printing inks
- Adhesives

ADHESIVE GRADES (Low Chlorine Type)

CHLORINATED POLYPROPYLENE
 CHLORINATED ETHYLENE VINYL
 ACETATE COPOLYMERS
 etc.

APPLICATION

- Gravure printing inks, adhesives for untreated Polypropylenes
- Primer for plastics



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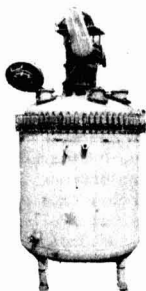
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LIST OF SECONDHAND PLANT & EQUIPMENT

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VERTICAL MIXERS & REACTION VESSELS, HEATED

R5800 5800 gal mild steel coiled mixer
N3450 3700 gal s/s jktd mixer



N3449 1000 gal m/s jktd reaction vessel
N3557 750 gal gls/ld jktd enclosed mixer
N4062 450 gal s/s jktd reactor
N3900 400 gal s/s jktd mixing trough
S4787 350 gal s/s jktd mixer
N4105 350 gal s/s jktd mixer
N3643 300 gal s/s jktd mixer
S5482 300 gal Pfaudler gls/ld reactor
S4944 225 gal s/s jktd reactor
S5483 200 gal Pfaudler gls/ld reactor
N3734 150 gal s/s jktd mixing vessel fip
S4204 120 gal s/s jktd reactors
N2719 100 gal s/s reactor/fermenter
N2593 100 gal s/s jktd reactor
S5665 100 gal Pfaudler gls/ld jktd reactor
S2731 75 gal s/s jktd reactor
N4049 70 gal s/s jktd reactor 100 psi
N3135 50 gal s/s jktd reactor
S5476 50 gal s/s high pressure jktd reactor
N4040 200 litre QVF reactor, heated
N4039 100 litre QVF reactor, heated
S5011 2 gal s/s jktd reactor for 600 psi

VERTICAL MIXERS, UNHEATED

N3309 1100 gal s/s open top mixer
R0773 350 gal m/s mixer 25 hp drive, fip

STIRRERS & AGITATORS

N3912 60 hp Silverson mixer 1470 rpm, fip
N3913 45 hp Silverson s/s mixer 1460 rpm, fip

JACKETED VESSELS, UNSTIRRED

B522A 2000 gal s/s jktd enclosed vessel
N3976 1500 gal s/s vessel with coil
N3557 750 gal glass lined jktd enclosed tank
N3900 400 gal s/s jktd mixing trough



N3875 350 gal s/s jktd enclosed vessel
N3588 300 gal Pfaudler gls/ld jktd pan
N3977 300 gal s/s jktd enclosed vessel
N3736 200 gal s/s jktd enclosed vessel

PRESSURE & VACUUM VESSELS

R0534 33000 gal propane storage tanks
BC501 5000 gal liquid ammonia tank
B397B 3500 gal s/s pressure vessel 100 psi
B397A 3000 gal s/s pressure vessel 250 psi
R375A 1250 gal s/s pressure vessel 35 psi
N3875 350 gal s/s jktd pressure vessel

AUTOCLAVES & STERILISERS

BC443 550 cu.ft. m/s autoclave 60 psi W.P.
N3659 250 cu.ft. s/s jktd autoclave
R375A 205 cu.ft. s/s autoclave 35 psi
N3656 45 cu.ft. s/s autoclave
BC538 24 cu.ft. s/s steriliser 30 psi
R0634 21 cu.ft. s/s autoclave 35 psi
N3558 15 cu.ft. s/s jktd steriliser 32 psi
S2839 10 cu.ft. s/s autoclave, 30 psi & vacuum

STORAGE TANKS, CORROSION RESISTANT

BC612 18000 gal s/s vert cyl tank enclosed
N4063 6000 gal h/d polythene vertical tank
N4064 5500 gal h/d polythene vertical tank
N3665 5000 gal s/s enclosed vert cyl tank
N4065 5000 gal h/d polythene vertical tank
N3526 4000 gal s/s horizontal storage tank
R728A 3500 gal r/l open topped tank
N3308 3000 gal s/s horizontal tank
N3272 2600 gal rubber lined horizontal tank
N2687 2000 gal s/s road tanker tank
on chassis
N3976 1500 gal s/s vessel with coil
N3733 1500 gal s/s enclosed vessel

PASTE MIXERS

N3335 Cruickshank 45 gal s/s bowl mixer
S4897 Peerless 100 quart s/s bowl mixer
N3604 Morton 80 quart s/s bowl mixer
S4083 Artofex size 15 dough mixer s/s
N2972 Artofex dough mixer 3' dia bowl 5 hp
S4621 Oakes mixer, s/s model 10 MPH 10 hp
S4437 B-Perkins hydisperser 12 gal s/s jktd
N3925 Beken Duplex 120 gal m/s type STAL50R
R768A Vickers Worsum 100 gal s/s z-blade
N3883 B-Perkins 50 gal jktd z-blade mixer
S5649 Morton s/s type N3 naben blade mixer
N3326 Winkworth 30 gal s/s paste mixer
N3538 Beken 25 gal m/s jktd z-blade mixer
N3952 Morton 20 gal s/s z-blade mixer model 3
N3886 Gardner 15 gal m/s jktd paste mixer
S4071 Baker Perkins 12gal m/s jktd z-blade
N3900 400 gal s/s jktd cheese mixing trough
BC828 Torrance 200 gal m/s paddle mixer
B522C Thouet 100 gal double arm paste mixer
N2693 Boulton 6" dia pug mill 10 hp
N3576 300 gal Lang emulsifier s/s
N3577 70 gal Lang emulsifier s/s

POWDER MIXERS

N3338 Gardner u-trough mixer m/s 125 cu.ft.
R857A Day u-trough mixer m/s 105 cu.ft.
N3917 Gardner u-trough mixer m/s jktd 50cu.ft
N3336 Gardner u-trough mixer m/s 35 cu.ft.
N3565 Pascall u-trough mixer m/s 20 cu.ft.
N3039 Gardner u-trough mixer m/s jktd 15c.ft
S5688 Gardner u-trough mixer s/s 15 cu.ft.
N3903 U-trough mixer s/s 15 cu.ft.
N3112 Alite u-t mixer & elevator m/s 14c.ft
N3365 Arenco Alite u-trough mixer s/s 8 cu.ft.
N3650 U-trough mixer s/s 7 cu.ft.
N3529 Vrieco mixer type S m/s 140 cu.ft.
R873A Air-mix powder blender 150 cu.ft.
S5320 Gardner Air-mix s/s 30 cu.ft. Komet C1
N3431 Double cone powder blender 65 cu.ft.m/s
N3522 Alite s/s double cone blender 16 cu.ft.
N4080 Sewin double cone blender m/s 15 cu.ft.
N3217 Gemco double cone blender s/s 10 cu.ft.
N3745 Double cone blender s/s 8 cu.ft.
N3744 Double cone blender s/s 4 cu.ft.
N2961 Sturtevant drum blender m/s 40 cu.ft.
BC616 Drum blender m/s 100 cu.ft.
N3914 JENKINS U-TROUGH MIXER S/S JKTD CU.FT.

S4503 Winkworth d/drum mixer 12 cu.ft.
S3423 Foster rotocube blender s/s 6 cu.ft.
S5259 Twin screw mixer conveyor 12" wide
9" deep
N2332 Trianco double paddle mixer m/s 30cu.ft.

GRINDERS & CRUSHERS, DRY

R0657 Donaldson Majac jet pulveriser size O4
R857B Mitts Merrill 130 SD RH plastic chopper
R851A Miracle swing hammer mill 100 hp
BC647 Scott Reitz hammer mill m/s 75 hp
N3340 Barron fixed beater disintegrator 30 hp
N3762 C-Norris model B7/2 swing hammer mill
BC589 Sturtevant hammer mill 20 hp m/s
N2556 H-Carter fixed beater disintegrator 15hp
N3595 C-Norris hammer mill size 22"
S3662 C-Norris hammer mill,s/s, 12.5 hp
N3719 Bramick mikro pulverizer type 2TH
N3743 Mikropul s/s hammer mill type 1SH
S4016 Mikropul micro-atomiser, s/s, 7.5 hp
S5082 Blackfriars rotary cutter s/s 7 c/i 10hp
N3993 Blackfriars rotary cutter model 18/36
N3519 Apex comminuting mill s/s 7.5 hp
S5301 Manesty homoloid s/s hammer mill 3 hp
R870B Chrispro 20" microniser
R802A Edgar Allen No. 6 sieving ball mill
S4851 Allis Chalmers vibrating ball mill
R247B Parker jaw crusher 36" x 24"
S5747 Parker jaw crushers 12" x 7"
S5746 Sturtevant jaw crusher 6" x 4"
N3635 Sturtevant jaw crusher 5" x 8" jaws
R874B Peat Drewery roll crusher 30 hp
R0764 Seck malt mill six roll 28" long
R0530 Bauermeister turbo pin mill m/s 50 hp
R870C Kek model 4H pin mill 10 hp flp

GRINDERS & CRUSHERS, WET

S4815 Hurrell homogeniser C12, s/s, 30 hp
S4814 Hurrell homogeniser s/s type C6 10 hp
R829B Fryma s/s colloid mill 25 hp
S5359 Moritz super colloid mill type BF150
N3514 Premier emulsifying & disintegrating m/c
N4041 Pestle & mortar 14"dia 5"deep chrome/p
R0875 Torrance ball mill porc lined 60"x 60"
R842B Ball mill steel lined 52"dia 50"face
R842A Ball mill steel lined 42"dia 42"face

OVENS & DRIERS

N2447 Rotary louvre drier,6'dia,10' long m/s
N3896 Bowen s/s spray drier, lab size
N3897 Mitchell 4 cu.ft. s/s double cone drier
N3738 Calmic 6 tray vacuum drier s/s model C51
N5654 Hedinair electric oven 4'x 4'x 3'fan cir
N3950 Kenwall tray drying oven 20 tray steam
S5645 Mitchell 20 tray drying oven electric
N3189 Simon twin roll drier 18" dia s-heated
B372C Sandvic band flaker s/s 4'wide 76'long
B489B Simon band drier 3'6"wide 20'long
R0855 Simon drier u-trough 8'long 3'wide 4 hp
N3913. Aeromatic fluid bed drier type ST60
N3916 Manesty Petrie fluid bed drier lab size
R840A Infra red conveyor oven 52"wide 45'long
R0699 Conveyor drying oven 3'wide 6'6"long
R0800 Sand drier oil fired 40' long
R0861 Sand drier 4'dia 30'long oil fired 15 hp

EVAPORATORS

R0343 APV triple effect evaporator 4 ton/hr
N4087 APV double effect plate evaporator

SIEVES & SCREENS

R798C Hummer screen 4' x 15' single deck
R802B Niagara screen m/s 4' x 7' 2 deck
N4107 Locker Rotex sieve m/s 3'3"x 7'6" 2 deck
N3934 Russell Finex s/s rect sieve 3'x 5'
R247A Parker Osselex screen 28' x 4'
BC570 Gough screen model GV/41 44" dia 1 deck
N3876 S/s braker sifter 24" dia 16" deep 10 hp
S4902 Russell s/s spiral sieve 9" dia 3' long
R851B British Rema air separator 6' dia

CENTRIFUGES

R869A Sharples pusher type centrifuge CD3000
R869B Krauss Maffei pusher type SZ 50 B
BC503 Sharples decanter centrifuge P3000 s/s
R0858 Sharples super decanter s/s type C2700
BC468 Broadbent decanter centrifuge 18 x 28
BC590 Flottweg decanter centrifuge model 22LL
BC598 Flottweg decanter centrifuge model 234
S5618 GVS s/s decanter c/fuge 7.5hp model K120
R798D Broadbent Bird scroll centrifuge 200 hp
N3213 Broadbent type 46A s/s ploughing centri.
BC652 Sharples super-d-hydrator model C2700
N2681 Broadbent 48" r/l/d basket centrifuge
N3451 Broadbent 30" dia r/l/d centrifuge
N3978 Manlove Allott 26" s/s basket centrifuge
R0828 Reinveld s/s centrifuge type CP330C
R829A Sharples superscreen s/s type 250-5-50
R0831 Tema worm screen centrifuge s/s size 520
BC630 Krauss Maffei 48" s/s basket centrifuge
N3497 Krauss-Maffei 24" s/s basket type V4 A/E
BC001 Alfa Laval pusher centrifuge type SB160
R343B Alfa Laval type BRPX309-34S disc stack
R484A Sharples autojector centrifuge type DW33
BC161 Sharples super centrifuge MV4 PIJY s/s
S5709 Sharples super centrifuge type MP4
N3910 Sharples centrifuge type M-4-P-2211-43SS
N3990 Sharples centrifuge type M-35-32Y-5PY-1
R591B Dorrclone hydrocyclone type M50/10
R0839 Westfalia separator type SAMN5063

PRESSURE & VACUUM FILTERS

BC567 Eimco rotary vacuum filter 200 sq.ft.m/s
N2388 Paxman 100 sq.ft. rotary vacuum filter
R862A Paxman 75 sq.ft. rotary vacuum filter
S5748 Stockdale rotary vac filter s/s 10sq.ft.
BC556 Eimco 13.8 sq.m. flat belt vac filter
S3426 Niagara leaf filter titanium 200 sq.ft.
N3951 Sparkler filter s/s model 33-S-11
S4222 Meta filter s/s type 2629/4
BC364 Stella meta pre-coat filter 95 sq.ft.
N3229 Stella meta filter type 1238.10 10sq.ft.
S5196 PCI ultra filtration unit s/s
N3473 Johnson filter press c/i 30"x 30" plates
S4336 Johnson filter press s/s 23"x 23" plates
N2998 Haubold c/i p/frame f/press 18" x 18"
S3373 Johnson c/i f/press 16"x 16" plates

S5368 Carlson s/s filter press 15" x 15" plates
S5660 British Filters s/s pressure filter
N3757 AMF s/s filter model RDI
S3470 Bahco pressure filter s/s
N3940 Alfa laval s/s brush liquid filter

HEAT EXCHANGERS

N3182 850 sq.ft. shell & tube h/exchanger s/s
R603C 800 sq.ft. shell & tube h/exchanger m/s
N2571 200 sq.ft. titanium s/tube h/exchanger
N5336 187 sq.ft. s/s plate heat exchanger
N3301 161 sq.ft. shell & tube h/exchanger s/s
S5219 150 sq.ft. s/s shell & tube h/exchanger
S5058 140 sq.ft. plate heat exchanger s/s
N2570 125 sq.ft. titanium s/tube h/exchanger
N3462 120 sq.ft. s/s plate heat exchanger
S5707 94 sq.ft. s/s shell & tube heat exchanger
S4701 85 sq.ft. shell & tube heat exchanger
N3794 80 sq.ft. shell & tube h/exchanger s&m/s
N2569 75 sq.ft. titanium s/tube h/exchanger
S4475 Cherry Burrell Vogt instant freezer s/s
N3438 Rotopro s/s scraped film heat exchanger
S5294 Cherry Burrell thermutator model SWB 624
BC649 Johnson votator twin barrel 6" x 3' long
S5731 Johnson s/s votator 3" dia 12" long

COLUMNS

R729B Column 4' dia 30' long, s/s
N2753 Fractionating column, 14" dia 10' high
N3915 Packed column 12.5" dia 16' long s/s

FILLING & PACKING EQUIPMENT

N2988 Albro vac powder filler in line 3 head
N3211 Southall powder fillers, 50/5000 gms
N2978 Transmatic Fyllan s/s powder filler
BC638 Bexuda 4 head liquid filler
N3732 Bland shrink wrapper & sealer 2' wide
S5751 Polypack shrink wrapper type A2060, 24"
R0779 Pneumatic bottle feeder and sorter
R0345 Rondec R30 screen printer

FOOD PROCESSING EQUIPMENT

R0343 APV triple effect evaporator 4 ton/hr
R036A Ahlborn model 157 s/s plate pasteuriser
N3344 Twin track s/s chilling tunnel 7'7" long
S4475 Cherry Burrell Vogt instant freezer s/s
N3438 Rotopro s/s scraped film heat exchanger
S5731 Johnson s/s votator 3" dia 12" long
BC649 Johnson votator twin barrel 6" x 3' long
N3437 Westinghouse pasta extruder, 7.5 hp s/s
R768B Vickers twin screw butter extruder
R768C Vickers s/s butter flaker
N3323 Stephen combi-cut type CC200, 100 hp
R0612 Wetter fromat F53 frozen meat slicer
S4736 Creamery Package homogeniser type CP2
S4907 Jensen & Anderson homogeniser 12.5 hp
S3029 Jackson & Church pulp press s/s
R0546 Alfa Laval pasteurising plant 2 ton/hr
BC497 Holroyd mincer 10" 28 hp model KS
N4082 Strommen 100 litre bowl chopper
B650A Alpira 200 litre bowl chopper
B650B Holomatic burger former, large model 840A

N3737 Stainless steel sifter breaker 15 hp
N3652 Vegetable washer s/s 2' wide 10' long
R561A Thermoscrew blancher s/s 21' long
N3452 Thermoscrew blancher s/s 17' long 12' dia
N3947 Thermoscrew s/s jktd 8" dia 12' long
R561B Thermoscrew s/s 12' long
BC471 Thermoscrew s/s 14' long 18" dia
N3900 400 gal s/s jktd cheese mixing trough
N2972 Artofex dough mixer 3' dia bowl 5 hp
S4083 Artofex dough mixer s/s 3 hp
R866A Lehmann continuous roaster
N3940 Alfa Laval s/s brush liquid filter
N3657 Fucchini s/s shredding machine
R0867 Urschell dicer model L
R829D Bauermeister almond slicers
S5229 Schaub typé RFK s/s shredding machine
B522D Chocolate refining 3-roll mill 42" face
R0764 Seck malt mill six roll 28" long
R866B Richard sizer malt mill 14" dia 36" face
S5344 Streckel & Schrader whole grain cutter

TABLETING & PHARMACEUTICAL EQUIPMENT

B637B Manesty No 2 single punch tablet press
B549C Stokes Tl 1-punch tablet press
B637A Manesty B3B 27 station tablet press

PUMPS, LIQUID CENTRIFUGAL CORROSION RESISTANT

R375D 2000 gpm canpump R3X200 s/s 60 hp
N3893 800 gpm angle pump s/s 50 hp 2900 rpm
BC344 360 gpm Labour submerged pump, s/s 50 hp
S3481 200 gpm Deutsche ceramic pump 15 hp

PUMPS, VACUUM

N3597 Nash Hytor size L9 liquid ring vac pump
N3606 Nash Hytor type CL-703
S5484 Edwards speedvac model 240 M3/hr 10 hp

MECHANICAL HANDLING EQUIPMENT

N2488 Barrel lifting & tilting truck, 400K
R870A Warco tote bin tipper & feeder
R0185 Container lifting & transferring plant

HOPPERS & SILOS

R350L 4000 cu.ft. m/s hopper 12' dia 40' long
R840B 2500 cu.ft. flour silo
R840C 1200 cu.ft. s/s rectangular hopper
R350K 500 cu.ft. mild steel hopper

CONVEYORS, ELEVATORS & FEEDERS

R802C Chain & bucket elevator 40' lift m/s
R350G King drag link conveyor 1' wide 15' long
N2363 Drag link elevator s/s 13.5" x 5", 7' high
N3921 U-section s/s screw conveyor 19" wide
N3920 U-section s/s screw conveyor 18" wide
N3919 Screw conveyor s/s 16" dia 20' long
R350H Screw conveyor 12" dia 28' long m/s
N3012 Jktd screw conveyor m/s 12" dia 25' long
N3958 Screw conveyor s/s 6" dia 5'6" lift
N3959 Screw conveyor s/s 8" dia 5'6" lift
S5259 Twin screw mixer conveyor 12" wide 9" deep
N2147 Belt & bucket elevator s/s 11' centres

R350J Belt & bucket elevator 3' x 3' 60' long
N4058 Belt & bucket elevator 2'6"x 35' high m/s
N4060 Trough belt conveyor 26" wide 75' long
N4061 Trough belt conveyor 48" wide 52' long

GEARBOXES, VARIABLE SPEED

BC605 Morse 40 hp v/speed drive 0-1500 rpm
S4227 Carter 5A v/speed 12.5hp, 0-950 rpm

MISCELLANEOUS

BC603 1 ton Alkyd resin plant
N3933 Alexanderwerk powder compactor type 150
N3770 Electrolytic cell for silver recovery
N3791 Head Wrightson s/s pan granulator
N3790 Gustav Eirich m/s pan granulator
N3749 Vacuum resin casting plant
R0826 Kroenert hot melt wax plant
R405G Shaw 1,070 ton hydraulic press
BC417 Dixon model 164 12" wide coater & drier
R856A Hunt & Moscrop 16" paper calender
S5708 Sussmeyer solvent recovery plant D200
R0540 Sussmeyer solvent recovery plant 250 l/m
B482B Wet dust scrubber 51,000 cu. m/hr
BC434 Inert gas generator 200 cfm
BC484 Eberlin tissue coater/impregnator
R0796 Cooling tower unit 23m BTHUS

GENERAL LABORATORY EQUIPMENT

S5695 Griffin carbolite furnace 4"x 6"x 12"
S5721 Sauter electronic top pan balance RE2021
S5722 Mettler electronic analytical balance
N3957 Gallenkamp autoclave, vertical
S5474 Gallenkamp humidity oven type OV700
S5711 MSE superspeed 65 centrifuge
S5174 MSE solid bowl s/s centrifuge 10" dia

GENERAL TESTING EQUIPMENT

S4928 Coulter particle counter Model ZB
S5577 Activion digital pH meter
S4832 Shandon atomic ABS spectrophotometer
S5703 Pye Unicam SP8000 UV spectrophotometer
S5490 Wallace Shawbury curometer Mk V
S4547 Bellingham & Stanley type D polarimeter

PILOT PLANT EQUIPMENT

N2457 1 litre hydrogenation autoclave 350 bar
S5011 2 gal s/s jktd reactor 600 psi
BC007 100 litre QVF reactor, heated
BC006 QVF climbing film evaporator
S4222 Meta filter, s/s, 5 sq.ft.
S5309 Calmic 20 cm s/s pressure filter
BC001 Alfa Laval pusher centrifuge
N3556 Carlson s/s lab filter press 7.5" plates
N3916 Manesty Petrie fluid bed drier
S4803 10k capacity s/s bowl chopper
S5363 10 gal s/s jktd pan
S4758 3 gallon s/s pressure vessel, 150 psi
N3847 25 sq.ft. s/s plate heat exchanger
N3255 Sturtevant cone crusher 0.5 hp
S5495 Pascall triple roll mill 2" dia
BC417 Dixon model 164 12" wide coater & drier*

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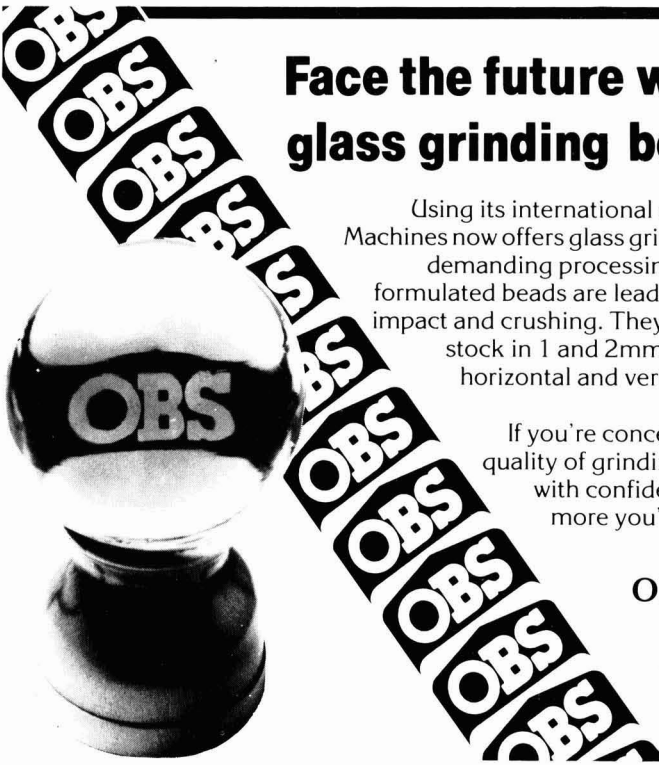
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Novel Corrosion Inhibitors

Z. Kalewicz

Research and Development Laboratory, Ets DERIVERY, France

Summary

The composite zinc-containing pigment composed of an electrically conducting nucleus of di-iron phosphide, intermediate Zn-diffusion interface coating, and fine particles of zinc metal surrounding the nucleus is described. Some corrosion performances as well as zinc consumption in accelerated tests as the function of total, initial zinc amount are given.

Corrosion of iron and steel, structural materials used for all crucial structures in modern society, is a very serious problem in all industries and the most common technology of protecting metals against corrosion is based on application of coatings.

Without protection steel structures tend to revert to their natural state of iron, i.e. iron oxide or rust.

Metal protection by organic coatings, so called primers can be effectively employed in anyone of three ways:

1. By resistance inhibition (barrier primers) where thick impermeable films provide a physical barrier to moisture, oxygen and ions and thus impede corrosion cell. These primers have very low permeability, either on account of their high build of densely cross-linked films alone, or by incorporation of flake-like pigments (glassflake, mica, aluminium powder), thus reducing the corrosion current to a negligible level. In this way the barrier primers also reduce the access of oxygen and moisture to the steel, thus inhibiting the cathode reaction, i.e. the reduction of oxygen to form hydroxyl ions.



In practice, however, protection by this mechanism is seriously curtailed by the high rates of oxygen and moisture transmission through most coating films and this not only through pinholes, holidays and all sorts of micropores, but also through the general, continuous film-forming material. In highly pigment loaded systems this occurs through the interstices between the pigment particles. In low pigmented systems, it takes place at the molecular level through sites which contain hydratable polar groups in the polymer molecule and which are more conducive than the general vehicle continuum to the attachment of water molecules. Once affixed within the continuum, the penetrating molecules work their way through the film via similar sites at lower levels of the film layers until they reach the metal surface.

2. By inhibitive primers, where small quantities of soluble compounds from the primer film are dissolved—as moisture diffuses through the coating film to the metal surface—and retard the electrochemical corrosion reactions. These inhibitors artificially increase the polarization of the anode and/or the cathode areas, acting as time-release agents that directly or indirectly supply inhibitive ions dissolved in the diffusing moisture. There are two distinct types of mechanism involved in the inhibitive action

of these pigments. In the first, the pigment itself actually dissolves and directly releases inhibitive ions to the metallic interface where they passivate the metal surface by polarisation of the anode and cathode areas (Figure 1).

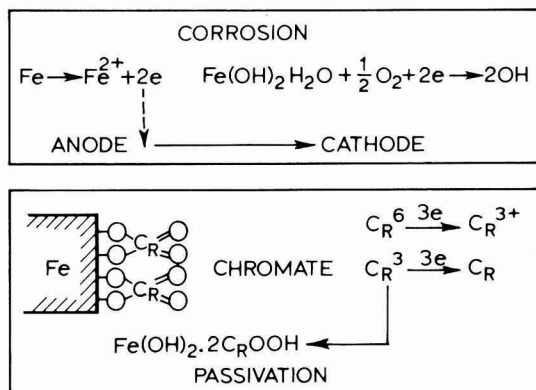


Figure 1. Passivation mechanism by water soluble chromates

Such inhibitors are generally referred to as the soluble pigment type and are exemplified by the chromates. They ionize in water to provide a source of hexavalent chromium ions—the active inhibitor. Chromates are available in a wide range of solubilities from the most soluble calcium chromate—Ca CrO₄—to the almost insoluble basic lead chromate—Pb CrO₄.PbO (Table 1).

Table 1

Concentration of chromate Ions provided in water solution¹

Pigment	Chemical composition (wt%)	g CrO ₃ /litre H ₂ O
Zinc Chromate	Zn-29.93	1.10
	K-8.95	
	Cr-23.81	
	O-36.62	
	H-0.69	
Strontium Chromate	Sr-43.03	0.50
	Cr-25.54	
	O-31.43	
Basic Zinc Chromate	Zn-56.45	0.02
	Cr-8.98	
	O-33.18	
	H-1.39	
Lead Chromate	Pb-65.1	0.00005
	Cr-12.4	
	S-2.4	
	O-20.1	

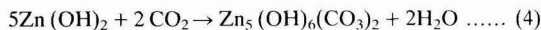
The second type of inhibitors belongs to the basic pigment class and is exemplified by the various lead-based pigments. It is believed that while certain lead compounds are themselves inhibitive in water their most efficient inhibitive action is afforded through soap formation. Specifically, basic pigments, such as red lead, have been proved to react in the film with acid breakdown products of some vehicle polymers forming very efficient inhibitive salts. These water soluble organic salts are presumably carried to the metal interface where they passivate the anode areas similarly to chromates.

Unfortunately, almost all the most effective pigments suffer from serious drawbacks². Red lead is highly toxic and there is legislation restricting its use in paint coatings. The hexavalent chromates are suspected of being carcinogenic and although there is no legislation at present limiting their application, several paint users have already prohibited the use of chromate-containing primers in different branches of industry. Other corrosion inhibiting pigments have been introduced on the market in recent years, claiming to be effective and of low toxicity but none have had major impact on the paint coating industry.

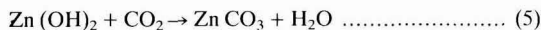
The subject of this paper is the development of novel corrosion inhibitor used in priming coatings and based on a principle of zinc rich primers (ZRP).

ZRPs are known as metal primers highly loaded with zinc dust in excess of their critical pigment volume concentration. It is generally accepted that ZRP—in steel protection—have both an active and an inhibitive role played by zinc metal and its salts³. The zinc-primed steel surface when exposed to an electrolyte is initially protected by galvanic action due to the zinc particles dispersed in the paint coating. At this stage the zinc dissolves anodically, offering cathodic protection to the substrate (Figure 2).

The mechanism of this protection is probably limited due to the formation of zinc compounds which react with hydroxyl ion produced on the cathodic sites and other environmental anions.



and



At this second stage they act as cathodic inhibitors to the steel substrate.

Although offering considerable corrosion protection these systems present often several serious shortcomings: relative high cost due to rising prices of zinc, poor adhesion to the metal substrate, and poor adhesion to organic top-coats and blistering in humid, environmental condition. They also interfere and bring about poor weldability and reduced torch cutting of coated steel substrates at film thicknesses above 25 microns. The attempts to correct these deficiencies either by the addition of various formulating aids to the ZRP or by the replacement of some of the zinc dust were not fully successful. The concept of the composite zinc-containing pigment, composed of an electrically conducting nucleus and encapsulated in zinc metal was based on the fact that the total quantity of zinc dust dispersed in ZRP and anodically consumed by electrochemical reaction is relatively very low.

Thus different quantities of zinc metal ranging from five

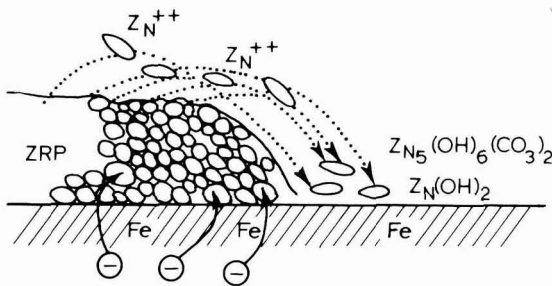


Figure 2. Protection mechanism of ZRP

to 65 wt per cent of total weight of pigment have been tested. The electrically conducting material for pigment nucleus di-iron phosphide (DIP) has been selected. DIP is produced together with phosphorous in the electric reduction process of phosphate rock, and is composed principally of Fe₂P with traces of FeP and SiO₂. X-ray analyses have shown DIP to consist of Fe=61-70 per cent, P=18-24 per cent, Si=2.5-4.5 per cent and Mn=2.3-3.5 per cent with traces of other metals. DIP is a hard, grey, refractory alloy with specific density 6.53 g/ml and melting point of 1320°C. When ground to pigment-grade. DIP is highly irregular in shape and can be obtained in different mean particle sizes. To produce our pigment with different quantities of zinc we used ball milling during 24 hours. The ratio of DIP to zinc is given in Table 2.

Table 2

Different composition of Zn-containing pigment

Reference	Zn/D.I.P.
A	5-95
B	10-90
C	15-85
D	20-80
E	25-75
F	35-65
G	50-50
H	65-35

Ground to a mean particle size of 6.5 microns DIP was mixed with a zinc powder R.V. (mean particle size 400-500 microns) and ball milled during 24 hours. thus obtained coated pigment is constituted of three elements: a core or nucleus of electrically conducting di-iron-phosphide, diffusion interface coating, and fine particles of Zn (0.3-0.5 microns) surrounding the coated pigment (Figure 3). Scanning Electron Spectroscopy demonstrates the presence of Zn diffusion coating and fine particles of Zn up to 0.5 microns surrounding a core of DIP.

In order to determine the effectiveness of various ratios—Zn/DIP in corrosion inhibitors without carrying out a time-consuming evaluation in paint formulations a simple scraping test was adopted partially based on "The Thomson Corrosion Test".

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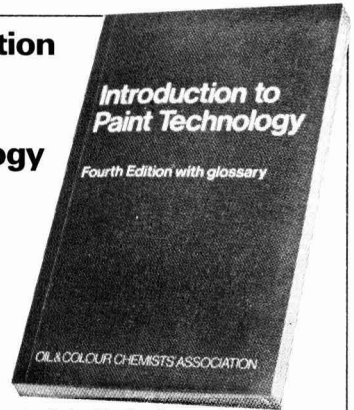


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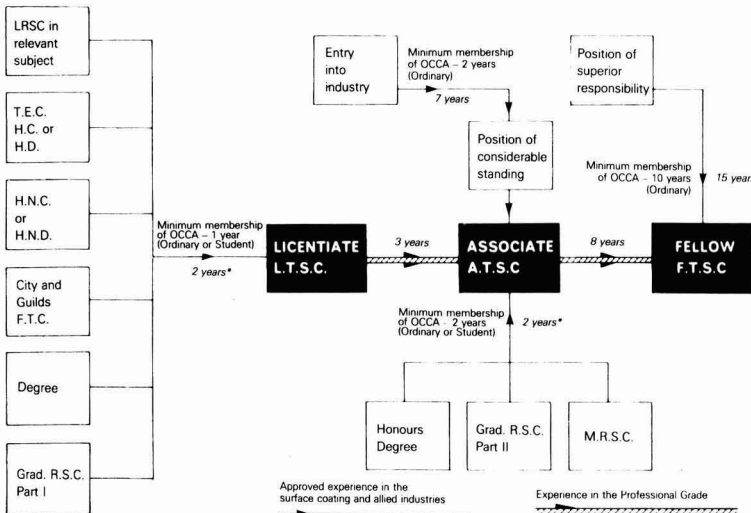
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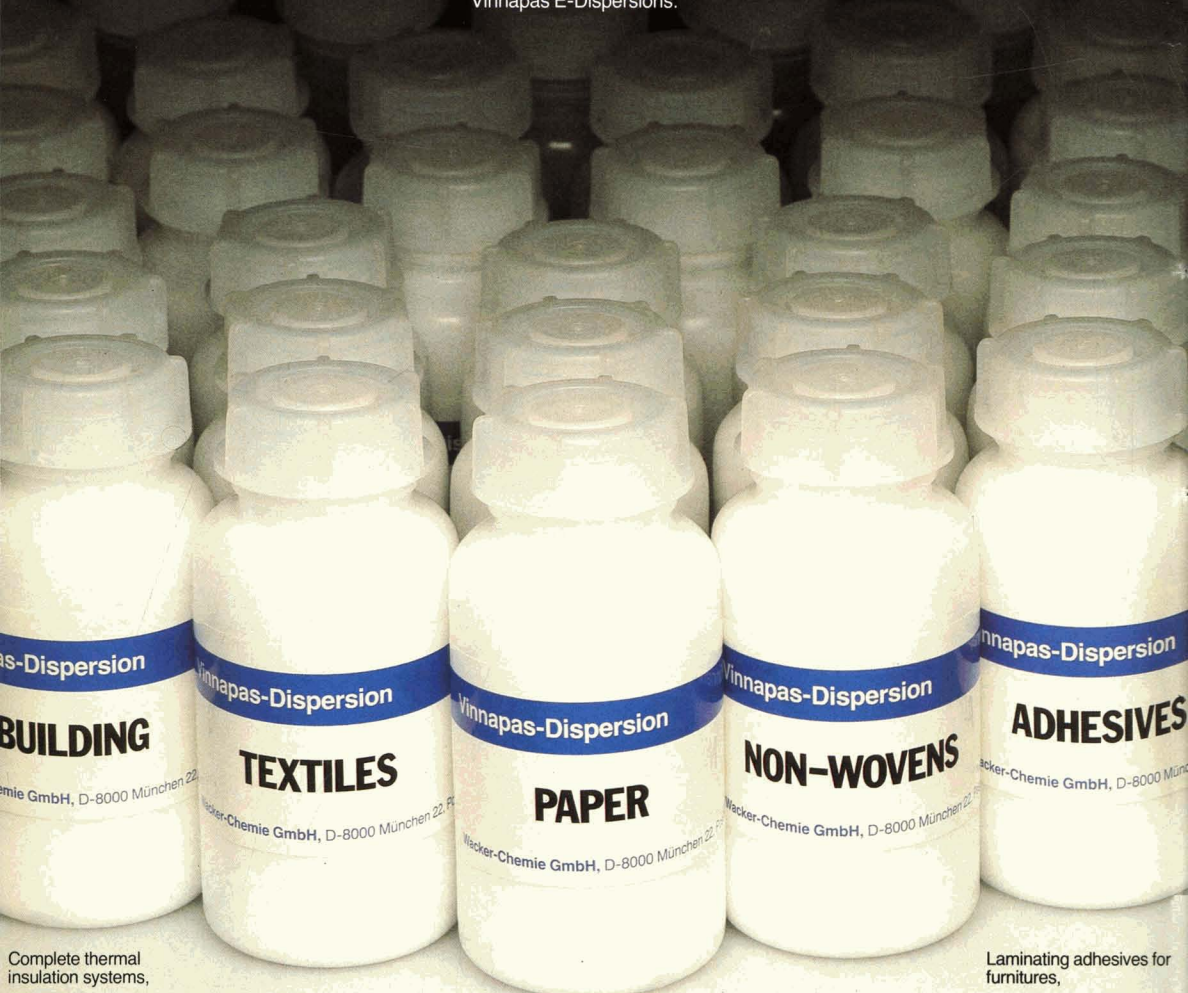
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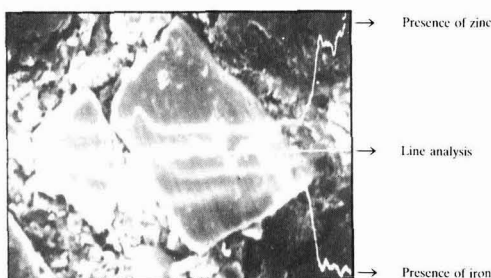


Figure 3. Scanning electron spectroscopy of 25wt. per cent Zn containing pigment (mag \times 2500)

A series of experiments was carried out in which the efficiency of zinc consumption was measured as a function of the ratio of DIP to metal zinc in a typical chlorinated rubber-based ZRP. The test plates coated with ZRP (25 microns) were dried seven days and exposed to salt spray according to ASTM method B117-73 during 250 hours. The per cent of unused metal zinc in coating was determined by scraping test plates. The removed coating was dried and weighed. The quantity of unreacted metal zinc was determined by the hydrogen evolution method. Table 3.

Table 3

Zinc content in the ZRP after 250 hours exposure to salt Spray (ASTM-B117-73)

Reference	Zn, DIP (wt %)	Total amount of consumed Zn (wt %)	Corrosion grade after exposure (%)
A	5-95	56.3	100
B	10-90	27.9	95
C	15-85	18.4	65
D	20-80	10.1	25
E	25-75	8.7	0
F	35-65	17.3	0
G	50-50	35.6	10
H	65-35	45.3	25

Table 3 gives the total amount of metal zinc in wt per cent consumed after 250 hours of salt spray exposure as a function of the initial zinc content and Zn/DIP pigment ratio. The last column of the table shows the rusting degree of the corresponding plates as a function of initial content of metal zinc in inhibitor pigment. These data are expressed graphically in Figure 4, where the per cent of unused zinc remaining and the rusting degree after salt spray exposure are plotted against the weight per cent of initial zinc in the pigment.

On the basis of these results a composite pigment containing approximately wt 25% of metal zinc and obtained by ball milling, was chosen for full-scale development and assessment in both organic and inorganic (silicates) coatings. Some of the performances of this inhibitor are discussed in Table 4.

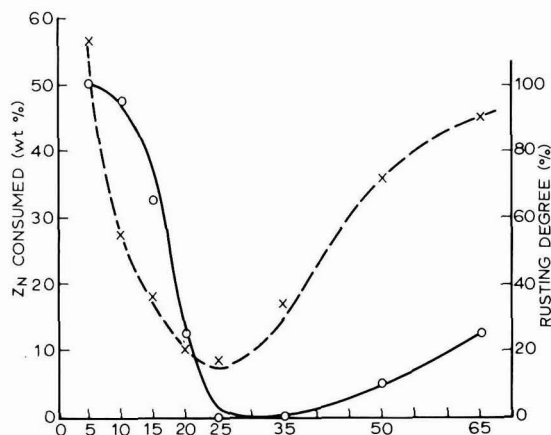


Figure 4. The percentage of consumed zinc and rusting degree as a function of the total initial amount of Zn in the coating

As can be seen from figures 5, 6 and 7, primer pigmented with zinc alone showed extensive blistering, while other primers, even pigmented with 25wt per cent. Zn, gave good corrosion protection. As shown in Figure 4 there was a remarkable coincidence between corrosion performance and zinc consumption in ZRP systems.

It seemed that in certain condition of exposure, corrosion protection passes through a maximum as the ratio of zinc metal to the di-iron phosphide nucleus approaches 20-35wt per cent. This was a rather unexpected result based on the

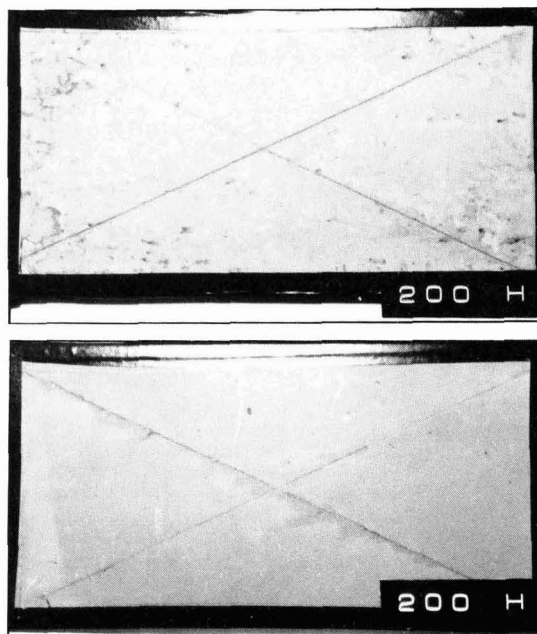


Figure 5. Shown above CR-A—Chlorinated rubber based ZRP, pigmented with 55:45wt. ratio of Zn to DIP. Shown below CR-B—Chlorinated rubber based ZRP pigmented with composite pigment (25:75)

Table 4

Results of accelerated testing of ZRP pigmented with zinc-DIP and composite pigment

Reference	Type of Formulation Thickness of coating, microns Exposure in hours	Salt spray ASTM-117 B-73 Film appearance	Substrate
CR-A	Chlorinated rubber, ZRP 55wt % zinc dust 45wt % DIP:—50 microns 200 hours	No blisters Slight rust at scratch some white rust	No corrosion
CR-B	Chlorinated rubber, ZRP, the same amount of composite pigment (25:75) 50 microns 200 hours	No blisters Slight rust at scratch	No corrosion
CEP-A	Epoxy ester, ZRP 100wt % zinc dust, 50 microns 300 hours	Extensive blistering No corrosion at scratch	No corrosion
CEP-B	Epoxy ester, ZRP the same amount of pigment (25:75) 50 microns 300 hours	No blisters No corrosion	No corrosion
EP-A	Epoxy ester ZRP 55wt % zinc dust, 45wt % DIP, 30 microns 300 hours	No blisters some rust at scratch some white dust	No corrosion
EP-B	Epoxy ester ZRP, the same amount of pigment (25:75), 30 microns 300 hours	No blisters No corrosion	No corrosion

All paints described in Table 4 were prepared as Zinc Rich Primers and applied by spraying to the required film thickness. The coated plates allowed to fully cure for seven days in a dust free environment were tested in salt spray, according to ASTM B-117-73 (see figures 5, 6 and 7).

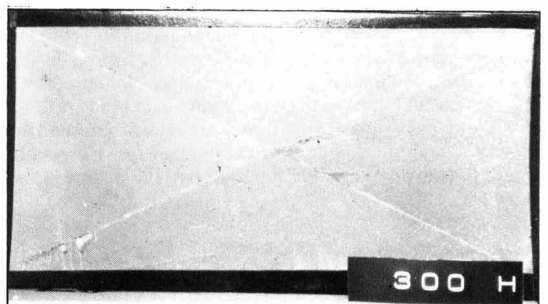
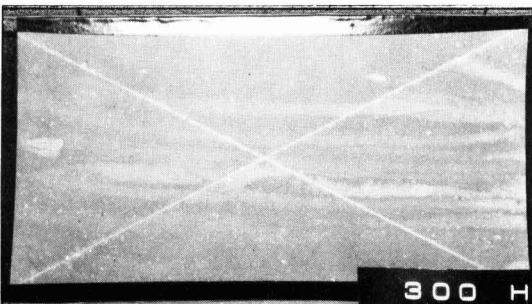
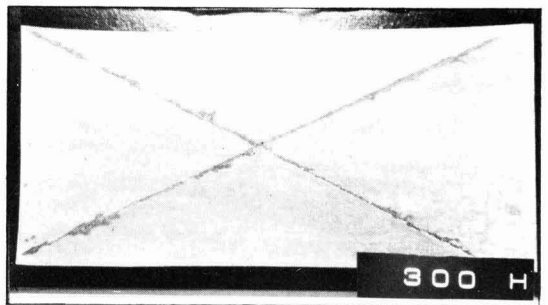
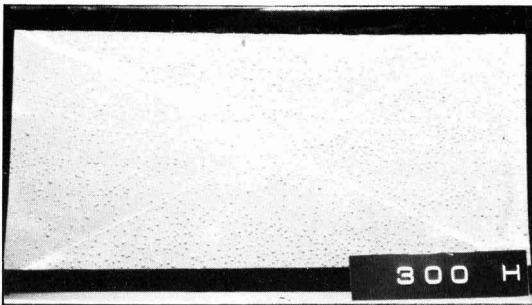


Figure 6. Shown above CEP-A—Epoxy ester, ZRP pigmented with Zn only Shown below CEP-B—Epoxy ester, ZRP, with the same amount of composite pigment (25:75)

Figure 7. Shown above EP-A—Epoxy ester ZRP, pigmented with 55:45 wt ratio of Zn to DIP. Shown below EP-B—Epoxy ester ZRP, with the same amount of composite pigment (25:75)

traditionally accepted idea of corrosion performance provided by zinc rich primers.

Further research work in our laboratory aims at explanation of active role of DIP nucleus in corrosion performance of composite pigment.

Certainly DIP has no corrosion inhibiting properties by itself, but as a nucleus of composite pigment with its Zn diffusion interface coating it has an active role, serving presumably as an efficient alternate cathodic site for hydroxide generation.

[Received 22 April 1985

- The paper "Formulation of solvent-based paints pigmented with titanium dioxide" scheduled for this month's issue will now be appearing in the January issue.

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next month's issue

The Honorary Editor has accepted the following papers for publication in the January issue:

Formulation of solvent-based paints pigmented with titanium dioxide by J. E. McNutt

New materials for the furniture industry by A. J. Sparkes

Polyurethane resins in moisture curable surface coatings by A. H. Hughes

JOCCA NOTICE

Performance of a novel corrosion inhibiting pigment of low toxicity, in ferrous metal primers, applied to marginally prepared surfaces

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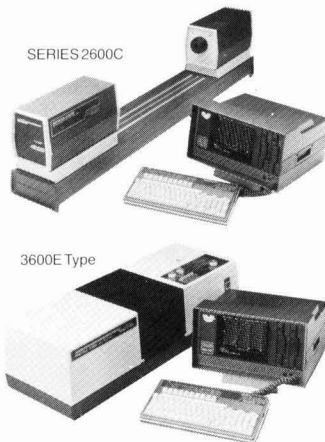
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Advances in the technology of water-based inks and coatings for the printing and packaging industries

G. H. Hutchinson.

Croda International Inks Federation

Summary

The past decade has seen an upsurge of interest in water-based inks and coatings starting with the need to conserve organic solvents, attention to environmental pollution problems and pressures from health and safety legislation. Research in this field has been particularly active in the USA because of legislation enforcing reductions in solvent emissions and interest has been maintained in Europe and elsewhere. There have been new outlets for water-based flexographic and gravure inks and overprint varnishes in the printing of absorbent papers and boards used in packaging. A promising development is the use of water-based inks for the flexographic printing of newspapers. In the printing of absorbent substrates, a study of available information on ink and substrate relationships is helpful towards a better understanding of ink drying performance. The drying problem remains the biggest obstacle to a more extensive utilisation of water-based inks, especially in the printing of impermeable plastic films and foils. More attention should be given to studying radio-frequency and infra-red heating techniques used in conjunction with conventional hot air drying systems. For the impermeable substrates, improved water-dispersible media are required to equal the best available organic solvent-based systems in respect of adhesion, chemical and product resistance properties.

Introduction

Recent years have seen significant progress in water-based inks and coatings for printing and packaging applications but compared with the phenomenal growth in water-based paints the advances in water-based inks have made much less impact on industry. This is not surprising if, in a broad comparison of paints and inks, one considers the nature of the products, the methods of application and end-uses, although when studying chemical and physical aspects both are concerned with film-formation on a substrate. The present contribution reviews progress so far, discusses some outstanding problems and looks at future prospects.

Factors influencing the growth of water-based inks

There was an upsurge of interest in water-based inks in the mid-1970's, stimulated by the need to conserve expensive petrochemical derived organic solvents, attention to environmental pollution problems and increasing pressures from health and safety legislation. The expanding packaging industry was to provide new outlets for water-based inks and coatings, exploiting the low odour characteristics of the products in the decoration and protection of food and confectionery wrapping.

Conservation of organic solvents

In 1974, the rising prices and shortages of petroleum made it essential for industry to economise in the use of organic solvents and water-based products received increasing interest. Then followed a period of economic recession with no major problems in availability of solvents therefore no

pressing needs for investigation of alternative water-based products. Even so, no one could predict the future economics of petrochemical derivatives and a situation could arise in which a period of shortages coincided with increased demand. There would then be a need for water-based products replacing organic solvent-based counterparts.

Environmental protection factors

Legislation enforcing reductions in organic solvent emissions has been particularly strong in the USA. Carlick¹ has described the various state and federal pollution statutes. These started with Los Angeles Rule 66, followed by the federal Clean Air Act 1970 and 1977 and the Environmental Protection Agency (EPA) guidelines requiring industry to reduce all types of solvent emissions. The 1978 EPA guidelines for flexographic and gravure printing operations recommended a maximum of 40 volume per cent volatile organic compounds (VOC) in high solids inks. For water-based inks, the volatile portion could contain a maximum of 25 volume per cent organic solvent and not less than 75 volume per cent water. Figure 1 illustrates diagrammatically some effects of pollution, a combination of circumstances such as led to Los Angeles Rule 66 legislation. This state legislation and the statutes set by subsequent federal legislation stimulated the development of 100 per cent non-volatile inks namely Ultra-Violet curing inks, Electron Beam curing inks and thermal curing ink systems as well as water-based flexographic and gravure inks.

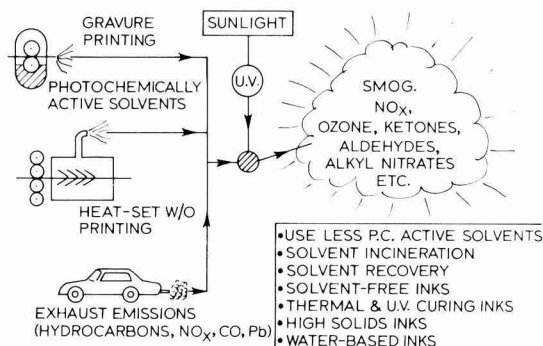


Figure 1. Effects of atmospheric pollution

In the UK there has been no legislation to enforce limits on solvent emissions but the UK Health and Safety at Work Act 1974 has far reaching implications for the development

Table 1.

Letterpress and Lithographic Inks - Drying Mechanisms

Type Ink or process	Principal Ink vehicle	Typical substrates	Principal Ink drying mechanism	Remarks
Letterpress W	Mineral Oil	Newsprint	A	Non volatile mineral oil
Letterpress S	Oleo-resinous and solvent	Papers, boards	A, O	High boiling range solvent
Letterpress S	Resin and glycol	Papers, boards	P	High boiling glycol
Letterpress S	Polyfunctional (acrylated) compounds	Papers, boards, foils	R	No solvent Ultra violet curing
Offset Litho W	Mineral oil and resin and solvent	Newsprint	A	High boiling solvent
Offset Litho S	Oleo-resinous and solvent	Papers, boards	A, O	(ditto)
Offset Litho S	Oleo-resinous and solvent	Tinplate	O, E (stoving)	(ditto)
Offset Litho S	Polyfunctional (acrylated) compounds	Papers, boards, foils, tinplate	R	No solvent Ultra violet curing
Offset Litho W	Resin/solvent	Papers	A, E (Heat-set)	Gas flame hot air High boiling solvent

A = Absorption; O = Autoxidative Polymerisation; E = Evaporation; P = Precipitation/Gelation; R = Photochemical polymerisation, Ultra Violet curing; W = Web-fed; S = Sheet-fed.

of inks free from noxious solvents and there is a provision in Section 5 (1) of the Act for controlling certain emissions to atmosphere. The requirements of the Act impose duties on manufacturers to ensure that their products are safe and without risk to health when properly used. Thus inks and coatings containing water as the major solvent component will help to increase safety in use because of the reduced fire risk, reduction in pollution of outside atmosphere and a cleaner press room environment.

Printing processes and scope for water-based inks

The mechanisms of letterpress, offset lithographic, flexographic and gravure printing processes are outlined in Figure 2. In letterpress and offset lithographic printing processes, a thin film of ink is carried to the printing plate by means of a train of rotating rubber rollers. Both these processes preclude the use of volatile organic solvents in the inks because of the swelling effect or attack on rubber rollers and blankets and because of their high evaporation rates which would lead to premature drying or tack development of the inks on rollers, blanket cylinders and printing plates. Water is also evaporated more rapidly than the high boiling aliphatic-type solvents normally used in letterpress and offset lithography and the evaporation is accelerated by the heat that can be developed (temperatures of 30°C or more) in the rollers after a period of running. Several different types of drying mechanisms may be operative in printing of letterpress and offset lithographic inks (see Table 1).

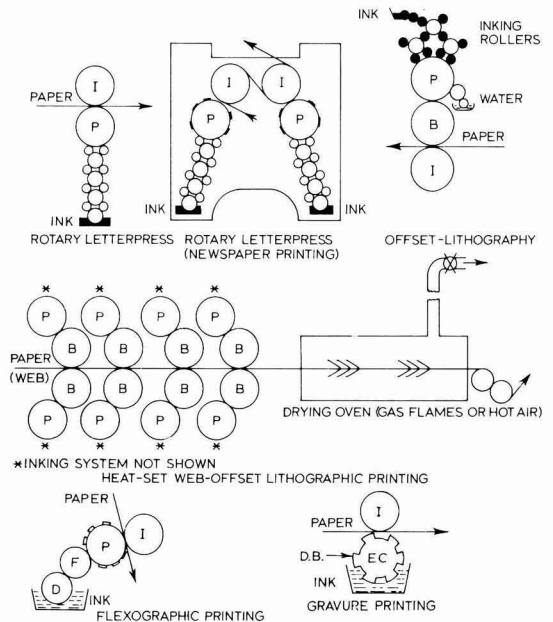


Figure 2. Printing processes

As shown in Figure 2 the ink distribution systems of flexographic and gravure presses are quite different from those of letterpress or offset lithography. There are no long roller trains and since the drying mechanisms depend mainly on evaporation of volatile solvent components it is not surprising that most of the development work has been on inks for these processes.

Some developments in water-based inks

Emulsion news inks

Early water-based inks for application by rotary letterpress machines were unsatisfactory. There was the "premature drying" problem because of high water content and tacky films causing paper fibres to be deposited on the plate. Emulsion news inks in which water is incorporated as the internal phase in a predominantly carbon black - mineral oil dispersion have less deficiencies than the early types of pigmented water-soluble vehicles. Provided the emulsions are stable to the shear forces that are operating, as the ink is transferred through the roller system, they appear to retain the good printability properties of conventional oil-based inks. Recent developments in the UK have given encouraging results. Complex oxidate acid soaps (chain length c_{18} to c_{44}) with high polarity and surface activity are used in the preparation of black rotary letterpress inks that can incorporate significant amounts of water. Stable inks containing ca. 40% water have been claimed². There has been insufficient experience with these inks to confirm that stability can be consistently maintained under different application conditions at such high water contents. Reduction of the roller train and insertion of an indirect anilox system (see Figure 3) is one way of modifying a conventional rotary letterpress machine and this could widen the scope for higher water content emulsion inks. Emulsion inks can show reduced "print through" compared with conventional oil based inks, less "rub-off" and reduction in misting tendencies.

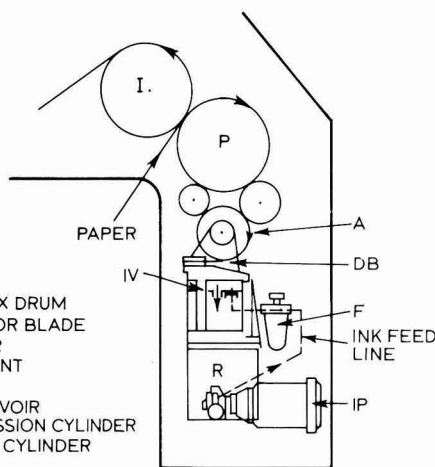


Figure 3. Indirect Anilox inking system (modification to rotary letterpress machine)

Flexographic inks

Water-based flexographic inks have been used commercially for some time mainly for printing boards for

corrugated cases, multi-wall sacks and paper bags. For these absorbent substrates the requirements have been for low cost inks producing a serviceable finish without any special resistance properties. The vehicles of early water-based flexographic inks were mainly aqueous solutions of alkali-soluble shellac or rosin maleates. In the early 1970's, water-dispersible polymeric media from petrochemical sources were investigated. Use of water-dispersible acrylic copolymers gave faster drying more water-resistant inks than the corresponding inks from saponified shellac or rosin derivatives. The improved film-forming properties were to be of considerable benefit to printers and converters. In the corrugated case industry, for example, there has been a recent demand for better print finish on white lined boards. The main objective has been to produce colourful designs giving more impact in the supermarket. Four-colour water-based inks printed from photopolymer plates have shown attractive results. Then there is the relatively new process of pre-printing the liner on modern wide-width flexographic presses in a reel-to-reel process prior to the corrugation. Fast drying heat-resistant inks are needed to withstand the high temperatures and pressures of the corrugating process. Wallpaper printing has been another outlet for water-based flexographic inks.

Flexographic inks for newspaper printing

Traditionally newspapers have been printed by the rotary letterpress process and over the past 25 years there has been growth in web offset lithographic printing especially for smaller circulation newspapers. Flexographic printing of newspapers is now of commercial interest in the USA, West Germany and Italy and under investigation in the UK. In the USA three newspapers are being printed by this process, using photopolymer plates and water-based inks³. A light weight press designed by the American Newspaper Publishers Association (ANPA) uses an anilox inking system as outlined in Figure 4. Advantages claimed for the new process over conventional rotary letterpress process,

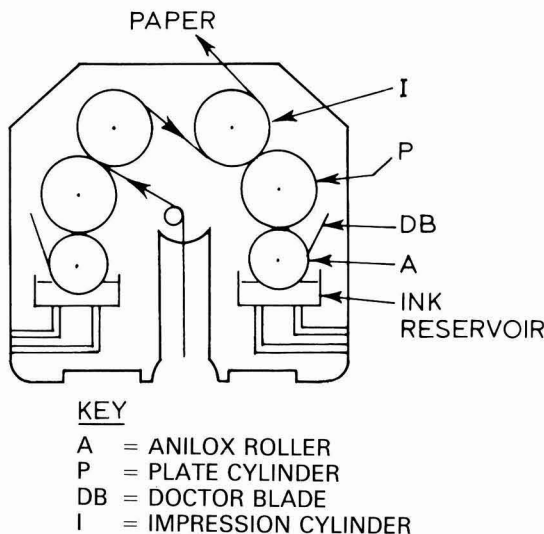


Figure 4. Direct Anilox inking system flexographic printing of newspapers (after Elsberg, E. 3)

include lower capital cost and reduction in maintenance costs, paper waste and noise levels. Improvements in print quality include less "rub-off" and reduced "print through". The reduction in ink misting is an important advantage.

Gravure inks

Earlier water-based gravure inks based on alkali-solubilised natural resins and derivatives gave two major problems; paper distortion during drying and insolubilisation of the inks in the 'etch' of the gravure cylinder when the press was stopped. A particular problem was the formation of an insoluble complex between the chromium metal and the shellac resin. The new alkali-solubilised acrylic copolymer led to improved inks with better machine stability and excellent drying on absorbent substrates. Work in the USA showed that with water-based inks, optimum printability with maximum printing speeds could be achieved with finer screen cylinders 175:200 lines/inch and a relatively shallow etch (10 to 25 μm depth). The solvent shortage period of 1974 stimulated developments in water-based gravure inks replacing alcohol-solvent based inks in sheet-fed printing of carton boards for chocolate and confectionary boxes. There were successful commercial runs for water-based inks in reel-fed gravure printing of football coupons replacing toluene solvent-based inks. Water-based gravure overprint varnishes have been used for some time to overprint alcohol solvent-based gravure inks on wrappers and carton boards for chocolate and confectionery products. The object is to ensure absolute minimum of residual print odour and avoid tainting of the contents. Water-based overprint varnish replacing normal alcohol-solvent type helps reduce residual solvents to specified acceptable levels.

Pilot press trials on four-colour water-based gravure inks for publication printing, have not been successful due to the distortion of coated paper stock. Drying temperatures had to be increased to achieve acceptable printing speeds causing unacceptable paper distortion over the heavily inked areas. Investigations are continuing but with the major gravure printing plants using efficient solvent (toluene) recovery systems there is little incentive for change bearing in mind the existing technical problems with the water-based inks.

Concerning Continental developments, water-based gravure inks have been used in West Germany⁴ to print wallpapers and decorative papers for transfer to pressed chipboard in the furniture industry. Another application is in offset-gravure printing of chipboard for the manufacture of imitation woods.

Water-based overprint varnishes and adhesives

There have been increasing outlets in packaging for water-based overprint varnishes that can be applied by roller coating, flexographic and gravure processes. The main advantage is to enhance the print finish or gloss and provide a protective coating to impart heat, water, chemical and abrasion resistance to the underlying print. For this field, developments in water-based polymers in solution, hydrocolloid and emulsion forms have proved invaluable. Table 2 summarises typical applications. Of these, there has been special interest in the use of water-based overprint varnishes applied wet-on-wet over freshly printed offset lithographic ink films using equipment illustrated in Figure 5. The water-based varnish is applied by the dampening

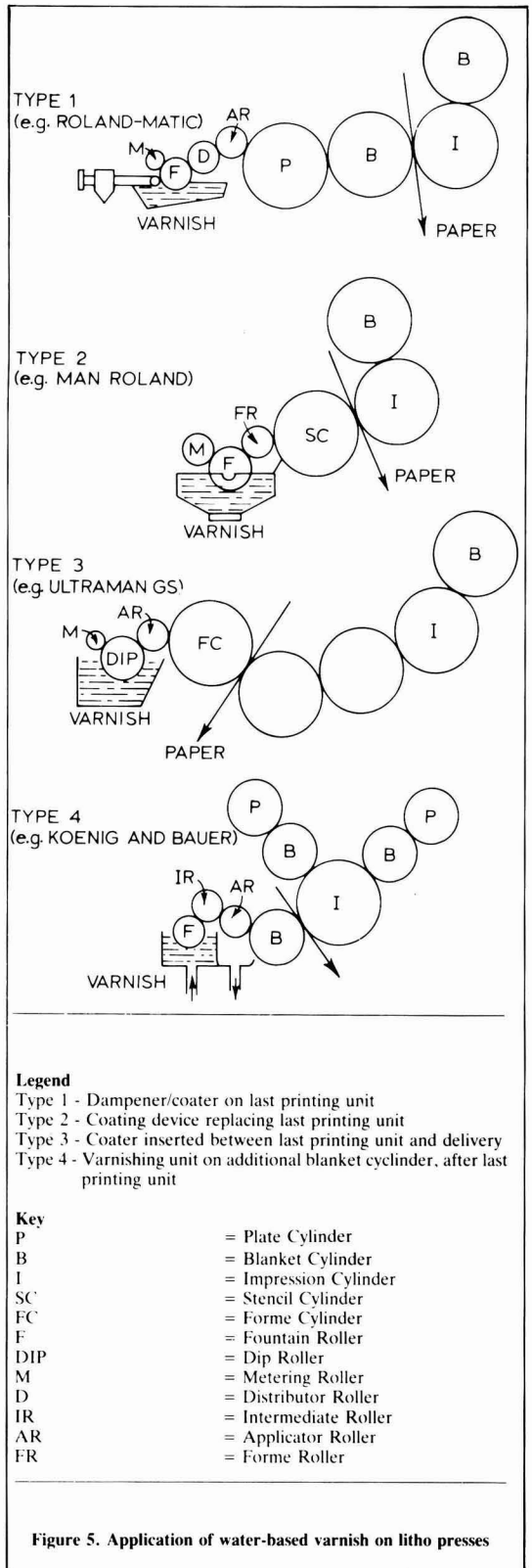


Figure 5. Application of water-based varnish on litho presses

Table 2

Some applications for Water-based O. P. Varnishes

Technique	Substrate	Typical End-use	Drying aid
Dampener/Coater on litho press Roller coating	Litho printed carton board Printed labels papers, boards	General purpose and food packaging General protection and gloss	None required Hot air
Roller coating	Printed carton board	Blister pack adhesive	Radio frequency Hot air
Gravure	Printed cigarette carton stock	Protection gloss etc.	Hot air
Flexography	Printed wallpapers	Spongable and washable	ditto
Flexography	Printed and plain paper/board	Paper Picnic plate decoration & protection	ditto

system of the last printing unit in a multi-colour process or from a separate coating unit attached to the press. Rapid drying varnishes give a protective seal over the print eliminating or substantially reducing spray powder usage while the underlying print can still absorb oxygen for autoxidative polymerisation of the ink film.

Water-based inks for impermeable substrates

There are two main problems restricting the use of water-based flexographic and gravure inks as replacements for organic solvent-based counterparts.

1. Water requires more heat energy to evaporate it compared with ink solvents of comparable boiling point.
2. Adhesion, water and product resistance properties of prints on flexible packaging films are generally inferior to those obtainable from best available solvent-based inks.

As an illustration, an aqueous ink based on phthalocyanine blue pigment and alkali-soluble acrylic copolymer was printed on treated polyethylene film using a laboratory gravure proofing press. After drying, the film exhibited good rub and scratch resistance and adherence to substrate (Scotch tape test) but after soaking the printed film in water for 24 hours the print was much inferior in these properties to a comparable alcohol-solvent based ink formulated on nitrocellulose and polyamide resin media. This pointed to a water sensitivity problem and indicated improvements would be needed for the inks to resist, for example, deep freeze conditions in food packaging. Figure 6 lists resin media and solvents used in flexographic and gravure inks. It shows that the ink maker has a wide choice of synthetic resin media used with appropriate organic solvents but somewhat less versatility with the more limited range of water-dispersible media.

Although progress in water-based inks for impermeable substrates continues to be slow, research in the USA has resulted in some commercial success¹. The promising outlets are flexographic inks for carry-out polyethylene bags, poethylene coated boards for milk cartons and reverse printed film overwraps. Continued improvements are being sought in water-based lamination inks and inks

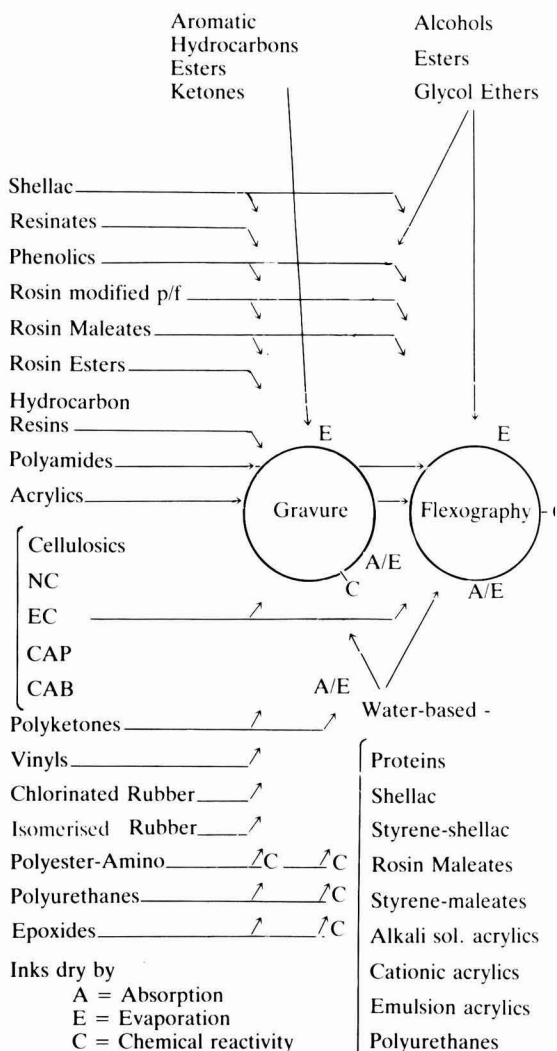


Figure 6. Liquid inks, resins and solvents

for polyethylene bakery wrapping. While improvements in chemical and product resistance properties are needed the major obstacle to real progress is the drying problem.

Aspects of the chemistry and technology of water-based inks

With the upsurge of interest in water-based inks investigations in the raw materials emphasised new film-forming media and to a lesser extent work on pigments^{5,6}. Other compounds for study would be organic co-solvents and ink additives such as wax compounds and surface active agents.

Film-forming media

While studies in water-based paints have contributed to developments in water-based inks there are different problems, particularly in the methods of application. As an example, on high speed printing machines, copolymer emulsions, dispersions of spheres of polymer (say 0.2 to 1.0 μ m), tend to coalesce when the water content is smaller than 26 per cent. Some very informative papers on water-dispersible ink media are by Sauntson⁷, Knightley⁸ and Firmin⁹. Sauntson⁷ described the alkali-soluble acrylic copolymer made by copolymerising a suitable acid monomer in the polymer chain. The deposited films are still water-soluble but become water-insoluble when the alkali is removed. If volatile amines are used to increase the pH, the reversion of polymer salt to the insoluble form takes place by a combination of mechanisms, mainly evaporation of the amine and neutralisation by the acids in the paper or board substrate. In the previous reviews^{5,6} the author adopted Sauntson's⁷ diagrams to illustrate the stages in the conversion of alkali-solubilised acrylic copolymer from an emulsion to a clear solution, as the pH is raised by addition of ammonia or an alkanolamine (see Figure 7). Models constructed from pipe cleaners were used to illustrate the sequence of viscosity changes. The solutions from emulsions have useful properties as media for flexographic and gravure inks. Pigments can be ball milled into them, pigment wetting and dispersion properties are good and the partially dried ink film is re-soluble in the ink. In contrast to the films from saponified rosin maleate type inks, the deposited films do not go through a "sticky" stage on drying. The intermediate colloidal dispersion stage (Figure 7) formed during the neutralisation of the emulsion has interesting properties as an ink medium. It develops wet rub resistance on film-formation, faster than the complete solution because there is less amine to be volatilised or neutralised for reversion to the acidic form. Drying is accelerated because the colloidal dispersion type is less water retaining than the solution polymer. Knightley⁸ discussed the so called shell emulsion polymers. Improvements in film integration for a given film hardness could be achieved with emulsion particles with hard inner cores and soft outer shells. Sequential polymerisation techniques are used to prepare carboxylated polymer emulsions that are alcohol dilutable. They showed considerable promise as overprint varnish media and as modifiers for water-based inks to increase polymer solids without increasing viscosity. There is now a well established technique of using solution polymer or intermediate colloidal dispersion type to disperse pigments in a ball mill or bead mill and then addition of emulsion polymer to up grade film-forming properties and give the preferred low viscosity/high solids product.

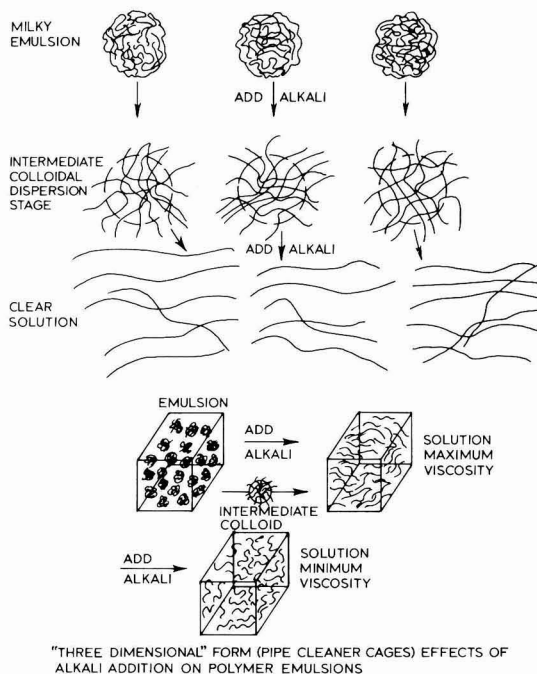


Figure 7. Effect of alkali addition on carboxylated polymer emulsions

Influence of co-solvent

The use of co-solvent for the preparation of water-soluble copolymer can affect viscosity, drying rate, stability, pigment dispersion ability and flow. For example, isopropanol addition can increase drying rate, reduce foaming tendencies and give a lower viscosity at equal solids.

Influence of the amine

The type of base used for the neutralisation of acid modified copolymer influences press stability, drying speed and water-resistance of the dried ink film. Typical amines are ammonia, morpholine, 2-amino 2-methyl 1-propanol, monoethanolamine, diethanolamine and triethanolamine. The most volatile amine ammonia should give most rapid development of water-resistance to the dried film at the expense of stability of the ink on the press. Using less volatile alkanolamines should give improved ink stability but water-resistance is reduced as long as they remain in the film. Amine volatility is not the only consideration and the structure, molecular weight and base strength should be taken into account. Low base strength could offset high boiling point in controlling amine losses from polymer films.

Typical resin and film-forming systems

Of the water-dispersible systems listed in Figure 6 the cationic polymer dispersions give superior alkali resistance properties to those from alkali-soluble carboxylated

polymers and they have received increasing interest. Colloidal dispersions of high molecular weight polyurethanes show promise as media for inks to print plastic films improving adherence and abrasion resistance.

Film-formation studies

Suggested drying mechanisms are illustrated in Figure 8 and combinations of these are likely. On absorbent papers and boards absorption and evaporation drying will occur the former being of more consequence in the case of water-based systems than with organic solvent systems.

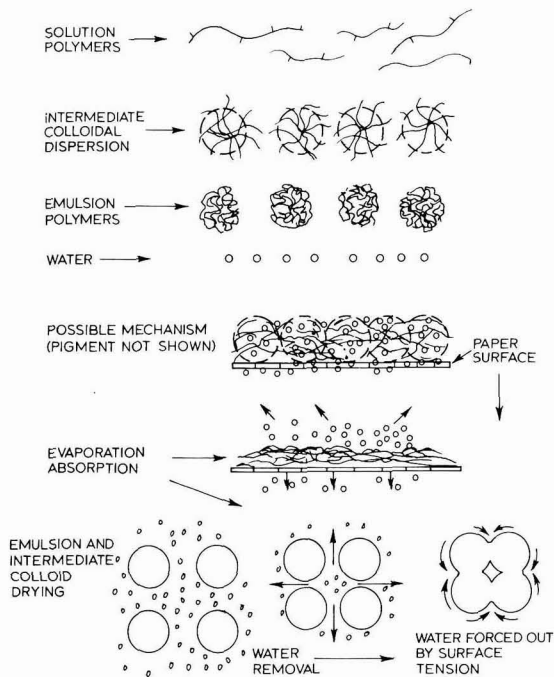


Figure 8. Drying of water-based inks

Pigments

Choice of pigments for water-based inks has been discussed in the previous reviews^{5,6}. Type of media, pH conditions, character of neutralising base and co-solvent type and concentration, influence choice of pigment. Traces of acidity in pigments can affect pH in such a way as to affect ink stability by viscosity changes. Problems due to residual acidity have been encountered with the bright pigments derived from lakes of basic dyes with complex phosphomolybdc acid or phosphotungstomolybdc acid. On the other hand the copper ferrocyanide complexes in violet, red, blue and green shades generally give no problems. There is a wide choice of suitable yellows, orange, red and blue/green pigments but with Rubine 4B (Pigment Red 57) and toner pigments in general it has been found that the acidic nature of the pigments results in some interaction between the pigment and the alkaline media resulting in de-metallisation of the pigment; this gives inks of poor flow and colouristic stability. Recently there has

been some progress with the development of a more stable rubine shade pigment. From pigment dispersion studies^{10,11} using dry pigment and pre-dispersed pigment preparations, there were marked differences in the dispersibility of three aqueous binders, saponified shellac, saponified rosin maleate and ammonium salt of vinyl acetate/crotonic acid copolymer. It was concluded that it would be difficult to find an optimum binding agent to suit all classes of pigment. Commercial pre-dispersed pigment preparations could be used to advantage especially with hard to disperse pigments in difficult dispersing media. Pigment preparations, for example, those based on pigment, surfactant, glycol solvent and water have been of increasing interest and recently high solids press cakes have become available. With a suitable surfactant present, the press cakes can be dispersed in the particular vehicle by high speed stirring, producing finished inks. On the other hand pigment preparations based on film-forming water-dispersible polymers rather than surfactant and solvent would no doubt lead to inks with better drying and water-resistance properties for application to plastic films and foils. Pigmented "chips" based on acid-modified copolymer resins have given better gloss results than dry pigment dispersions on various plastic films, but conversion of the chips to finished inks is subject to more variables than when using conventional pigmented chips in organic solvent media.

Improving inks for impermeable substrates

An outstanding problem has been to develop water-based ink systems giving suitable film-forming properties on plastic films and metallic foils. The use of reactive cross-linking systems is one route but balancing reactivity with press stability is still difficult. Considering the high printing speeds required and the limitations in drying temperatures that can be used for heat sensitive films it would seem that adequate curing in cross-linking resin systems could only be achieved with the less practical two-pack resin systems, for example, epoxide and melamine formaldehyde resins. Harder, more water-resistant films can be obtained by the interaction of multi-valent metallic ions with carboxylated polymer systems. Thus zinc ammonium carbonate at suitable pH gives stable inks, cross-linking taking place during the drying. A drawback is that such films are not ammonia resistant.

Ink and substrate relationships

Research at PIRA^{12,13,14} involved studies on the mechanisms of penetration of ink into paper. Uncoated stocks from the highly absorbent antique book paper to the low absorbency super-calendared (SC) paper were examined with oil-based carbon black inks. A reflectance technique was adopted and a relationship established between ink volume penetration and print reflectance. The distribution of pigment and vehicle in the paper pores was determined by section cutting and staining the sections with aqueous iodine to render the ink vehicle visible¹². An important finding of this work was that separation of pigment from vehicle was less with the highly absorbent antique book paper than with the low absorbency SC paper.

The flow of ink in a printing process may be divided into two periods, the forced penetration during impression and the free capillary absorption after impression. In general

both cases of penetration would be expected to obey Darcy's law of viscous flow¹⁴:

$$h^2 = \frac{kpt}{\eta} \text{ ----- (1)}$$

where p is the total pressure drop over a penetration depth h , reached in time t ; k is a constant depending on the permeable medium; and η is the viscosity. Hsu¹⁴ studied the forced penetration of a number of single litho varnishes, mixed litho varnishes, 'two phase' varnishes and experimental carbon black inks, into S.C. paper (printing pressure 400psi for 0.04 seconds). The results show that the forced penetration is governed by the classical law of viscous flow indicating that no separation of phases occurs during the impression. The situation is different in the capillary absorption stage when the vehicle penetrates further than the pigment. For a study of the penetration of ink varnishes using the capillary absorption stage, equation (1) can be written as:

$$h^2 = \frac{kC\gamma \cos\theta t}{\eta} \text{ ----- (2)}$$

where γ = surface tension of the liquid; θ = the contact angle; C a constant of the porous medium.

Using this relationship¹⁴ it was found that with the exception of one of the two-phase varnishes all the varnishes behaved as single-phase liquids. The low absorption of one of the two-phase varnishes could be explained by the thin dispersing medium draining into the paper pores, leaving dispersed resinous particles on the surface to form a 'gel' structure.

The results of the PIRA work are fundamental to an understanding of penetration drying behaviour of oil-based inks. They may also be of help to explain penetration setting of water-based inks and coatings.

With oil-based rotary letterpress news inks on the highly absorbent newsprint (see Figure 9) the impression pressure will force ink into the open pores of the paper, then capillary absorption forces will cause vehicle to be drained away. This promotes ink 'setting' and a highly pigmented ink is left in the upper surface layers of the paper.

Emulsion news inks will dry by a different mechanism. On printing impression, the emulsion should break and there is likely to be concurrent capillary absorption and evaporation of the water. The reduction in 'print through' of emulsion news inks may be explained by the lower mineral oil content leaving less oil available for filtration by capillary suction. After the water has separated, further penetration of the ink as a single-phase may be retarded. With water-based flexographic inks much will depend on the degree of absorbency of the substrate and capillary suction forces will tend to dominate on the lower absorbency papers. Influential factors will be the type of resin binder, resin solids, water content and pigment type and concentration.

The intermediate sticky stage found during the drying of aqueous rosin maleate ink systems may be ascribed to their greater tendency to retain water whereas the acrylic copolymer matrix is less water retaining leading to less tacky films. On very porous substrates however, a rather low concentration of alkali-soluble acrylic copolymer resin in inks diluted to 'press viscosity' could lead to over

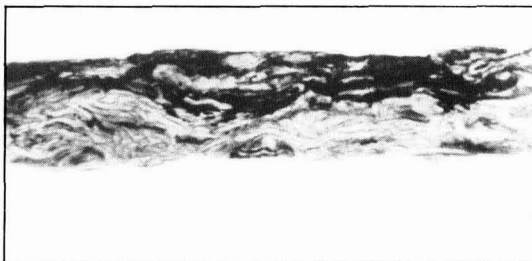


Figure 9. Printed section of newsprint showing penetration of pigment in the surface layers (mag. x 250). Photo courtesy of PIRA

pigmented films of poor finish and rub-resistance. Filtration of lower molecular weight constituents could not be excluded. This is one reason for the use of higher molecular weight emulsions to raise resin solids of the inks at printing viscosities. Hot air drying at temperatures say 70 to 80°C will increase the rate of evaporation of the water giving less opportunity for excessive penetration of vehicle components. Fine particles of emulsion could of course penetrate open pores and the rate of coalescence of polymer particles influenced by the air drying temperature, is of importance.

On coated papers and boards (see Figure 10) penetration of ink as a single liquid is not likely to occur as the very fine pores will filter out all but the finest pigment particles. In fact with modern quick-set offset lithographic inks, on impression pressure, a highly viscous pigmented oleoresinous complex remains on the surface while solvent and low molecular weight oils penetrate the minute pores in the clay coating. On coated papers even the vehicles for these inks will behave as two-phase systems so that the molecular size and geometry is such that only solvent and light oils penetrate the fine pores. The alkali-soluble acrylic copolymer, hydrocolloid and shell polymers used for overprint varnishes can form glossy films on smooth coated papers and boards. This suggests the initial film setting mechanism is not unlike that of quick-set lithographic inks and ink media although the viscosities are much lower. The problem with water-based inks is to get high enough resin solids at press viscosities. A higher rate of evaporation of the water will of course inhibit penetration but this will not be as rapid as with organic solvent based inks.

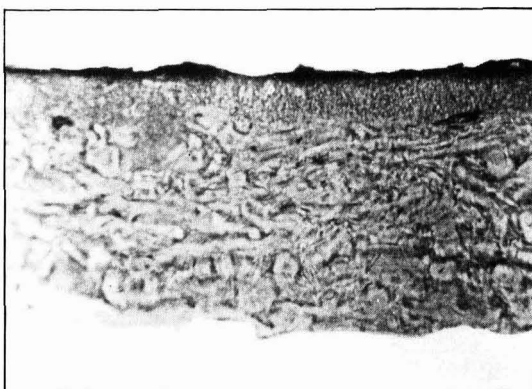


Figure 10. Printed section of a coated paper showing pigmented ink film on the surface

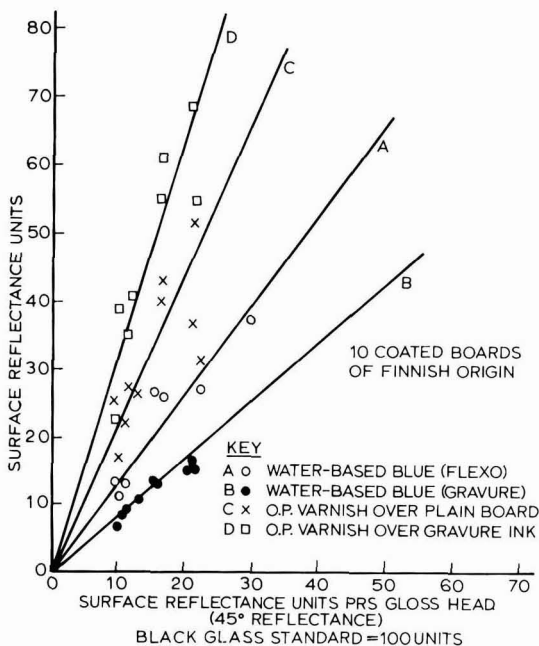


Figure 11. Print gloss-water-based inks and O. P. varnishes versus reflectance. (Clay-coated boards)

Effect of smoothness

With water-based varnishes applied in-line over offset lithographic inks printed on carbon boards, the best gloss is obtained on clay coated papers and boards where the clay coating has good smoothness¹⁵. It has been suggested that smaller and larger pores in the clay coating should be evenly balanced for uniform absorptive capacity. This appears to be very important for even distribution of gloss. Large pores tend to give good mechanical adhesion of water-based coating to the underlying ink film but somewhat less gloss when drying is complete. Small pores can be closed completely by the lithographic ink giving the water-based ink less chance to 'key'. The present authors company carried out an investigation^{6,16} on a series of different coated carton boards printed with water-based flexographic and gravure inks. It was deduced that the smoothest clay coated board measured by a surface reflectance technique (see Figure 11) gave best results in terms of overall print gloss (flexographic prints) gloss of overprint varnish over plain board (gravure) and gloss of overprinted varnish over printed areas (gravure). Ink absorbency by K & N Ink Absorbency test and water uptake by Cobb Value did not correlate with the print gloss but the most absorbent board with highest water up-take gave a very low reflectance value for printed and overprinted areas.

Aspects of the drying of water-based inks

With absorbent papers and boards the relative contributions of absorption and evaporation mechanisms of ink drying will depend on factors such as the porosity of the substrate, printing speed, film-weight of ink or varnish, temperature, humidity, volume and velocity of the drying air.

Effect of humidity

Humid air at ambient temperature say 15 to 20°C will retard evaporation of water so that atmospheric air at 80 per cent R. H. cannot accept much more moisture from a wet surface. Fortunately the capacity for air to accept water increases rapidly as the air temperature is raised. Evaporation of organic solvents is not appreciably retarded if the air is saturated with water vapour.

Improvements in existing air drying techniques

Hot air drying

No doubt the efficiency of air drying facilities on flexographic and gravure presses could be improved by paying more attention to volumes and velocities of the drying air. The work at the University of Bath¹⁷ involved studies of high velocity air jet drying and analysis of the constant rate period of drying of inks. This important work provides data for designers of press drying equipment.

Infra Red Heating

Short wave Infra Red drying modules are sometimes used at the delivery end of offset lithography presses to accelerate the drying of sheet-fed inks. These compact dryers are also useful for accelerating evaporative drying of water-based coatings and inks. When they are used for drying high speed printed webs, a good flow of air is required to remove the water vapour.

Radio frequency heating

In the mid 1960's microwave heating at a frequency of 2450 MHz was used to dry web-offset inks on newsprint (see Figure 12). This was not successful because the inks were

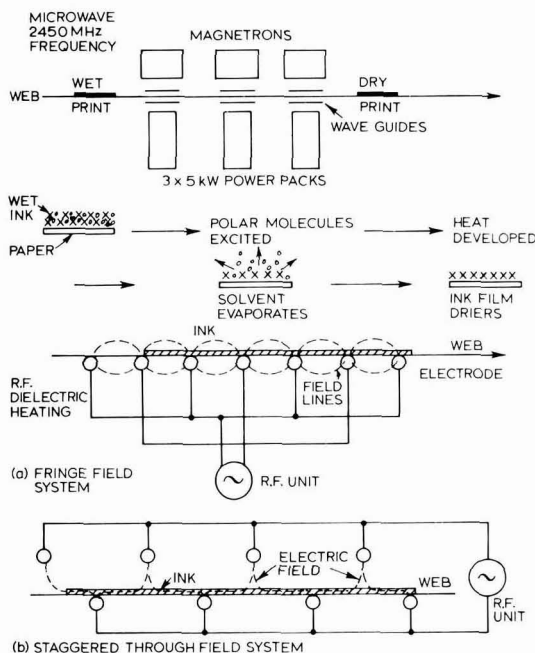


Figure 12. Radio-frequency drying

Expansion in product range and markets

This edition of Sheen News brings more new products to your attention as well as reminding you of some well established instruments in our range.

Since our entry into the market for thickness measuring instruments, we have established a strong position as suppliers of high quality, low cost products.

This year we are pleased to announce (see page 3) the introduction of a complete range of hiding power/opacity charts made by us in England.

Our current range of products now makes Sheen a leading world supplier of specialist instrumentation for surface coatings.

Alan Routs

Alan Routs

Managing Director

Powder coating fault finder solves problems for Kenwood Mixers

A growing number of powder coating users – and trade coaters – are now using the Sheen electrostatic powder coating diagnostic kit.

At the Thorn EMI factory at Havant, home of the Kenwood Chef and other Kenwood mixers, aluminium castings are electrostatically coated with white

Boom in pocket Gloss Meters

The advantages of the Sheen 100 Pocket Glossmeter in quality control for quick but accurate checking of gloss has led to a boom in sales over the past twelve months. Apart from demand by the many industries using paints and surface coatings, its uses now range from measuring gloss on polished metals, plastic film laminates, to lipsticks and nail varnishes.

In all these areas, gloss levels are being controlled to within 1 per cent of a known standard, using the Pocket Glossmeter.

It measures only 150 x 100 x 50mm and operates on a rechargeable battery. It conforms with ISO 2813, BS 3900.D5, ASTM D523, and DIN 67530 for the measurement of specular gloss. Operation is fully repeatable.

The Pocket Glossmeter is available with either 60° or 20° angles or a combined 60°/20° version.

Features include: auto control of lamp brightness to compensate for

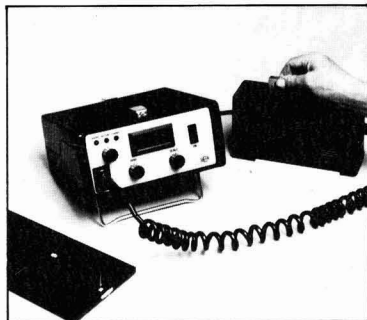


ageing lamps; robust construction and design give long term reliability; digital display reading to 0.1 gloss units; auto hold facility to minimise battery usage.

Special versions of this instrument are available for very high gloss surfaces – metallised packaging films, polished steel and extremely low gloss finishes such as special papers.

and the 150 glossmeter

The 150 also conforms to all international standards indicated above.



The solid state digital read-out is separate from the sensing heads which are interchangeable and available in the following optical geometries: 60° for general purposes; 20° for high gloss finishes; 85° for low gloss/matt finishes, 45° for special requirements.

Statistical analysis, recording and hard copy print-out will be available shortly.

epoxy powder to give a dry film thickness of 75-100 microns. Here, they have found the Sheen diagnostic kit invaluable in obtaining consistent optimum performance from their powder coating system.

This easy-to-use instrument helps to eliminate common faults in coating efficiency such as:

- Orange peel effects
- Pinholes/holidays
- Adhesion
- Poor quality powder
- Wrong current/voltage
- Fused coating pullaway
- Back ionisation



Think of Surface Coating Testing... Think of Sheen

SS1000 measures coating thickness on ferrous or non-ferrous substrates

Following on the success of the SS1200 for measuring coating thickness on ferrous substrates and the SS600 for non-ferrous, the new SS1000 digital coating thickness gauge gives accurate measurement on either ferrous or non-ferrous substrates.

The SS1000 is equipped with two probes: one for ferrous and one for non-ferrous measurements. Its ferrous range is 0-1000 microns (40 thou/mils) and non-ferrous is 0-500 microns. A compact and readily portable instrument, it is equally at home in the quality control office, the laboratory, the factory or on site outdoors. It is powered by a 9volt battery, or for bench use a mains 110/230 volt adaptor can be used (7.5 volt DC).

The Ferrous channel is for measurement of coatings on structural steel, steel pressings such as car bodies, cast and wrought iron. All coatings which are not magnetic can

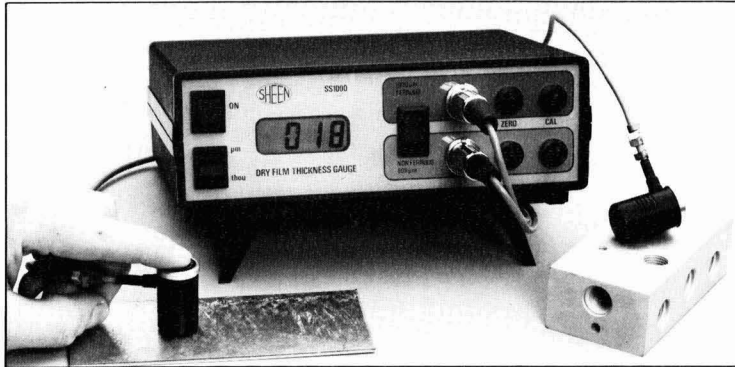
be measured, including electroplate (except nickel), paint, powder, plastics. The full calibration controls facilitate the measurement of coatings on blast cleaned or curved surfaces.

The Non-Ferrous channel measures most conductive coatings on non-ferrous metals including zinc alloys, aluminium, brass and bronze. Coating thickness of paint, powder, ceramics, plastics and anodised aluminium may also be measured.

Both probes feature constant pressure loading of the probe tip which ensures consistent performance and very long life.

Special probes for use on small plated surface areas, e.g. screw heads will soon be available.

Compatible Statistical analysis, recording and hard copy print-out facilities will soon be available for our SS1000/SS1200/SS600 instruments.



Low Cost SM Analogue Range

As well as carrying out standard thickness measurements, the low cost SM range has a selection of probes for special requirements.

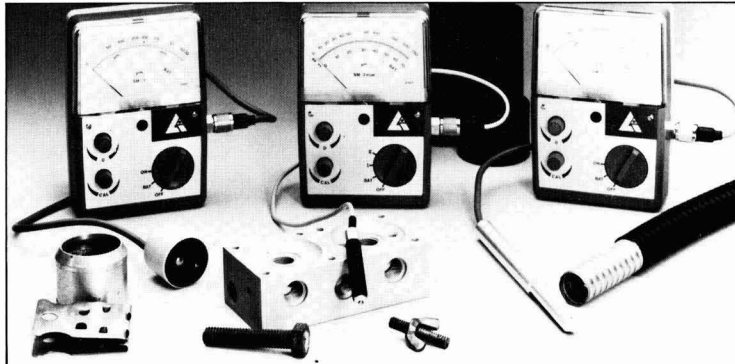
These include thickness measurement on the inside of pipes and tubes, small surface areas,

curved surfaces, cross sections, etc.

Measures non-magnetic coatings (including electroplate) on steel.

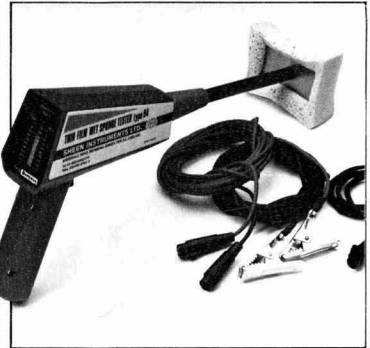
All probes are compensated against temperature effect and are mostly interchangeable.

Long battery life – up to 1000 hours on a 1.5V battery.



Pinhole Detector – Type 84

The recently introduced wet sponge pinhole detector, Type 84, is for use on thin coatings on an electrically conductive substrate. It has a dual range: high sensitivity with resistance of 200k Ohms and low sensitivity with 82k Ohms. It will test a maximum thickness of 350 microns.



The value of the resistance can be read off the graduations on the appropriate scale. An alarm will sound when an illuminated bar rises to the first red light on the display. The last red light denotes a short circuit, i.e. no resistance through the coating. Thus, when the maximum number of lights is displayed, the sponge is over the fault in the coating.

Battery operated, with charger for 240/110v mains supply provided, it is distinguished by its lightweight ABS pistol body. The whole unit, including charger, weighs only 2Kgs.

Now the underwater coating thickness gauge

An example of Sheen's innovative and design capabilities is the development of the world's first underwater thickness measurement gauge. The UTT 1500 will test the thickness of paints, plastics and other protective coatings on ships and underwater structures. The unit has been designed specifically for use by divers.

The fully sealed Delryn housed instrument is suitable for use at depths down to 443 metres: it is pressure tested to 600 psi before despatch.

The 3½ digit display is back illuminated, reading 0-1500 microns to an accuracy of ± 2%.

What's new in viscometers

Stormer Krebs-LED version



The digital Stormer Krebs viscometer features an LED indicator.

This glows green immediately the internationally specified speed of 200 rpm is attained by the paddle which is inserted into the material under test. The force needed to drive the paddle

at this standard speed is created by a measured weight load, applied through a pulley assembly in accordance with international specifications.

The LED readout replaces the stroboscope or clock gauge, which are more tedious methods of checking the test speed of 200 rpm.

RV-8 spindle viscometer

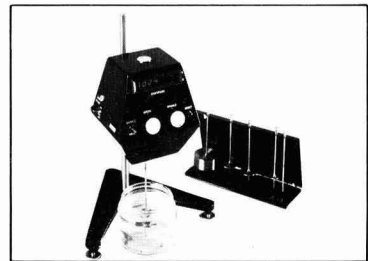
The RV-8 spindle viscometer measures viscosities from 100 – 8,000,000 cps. It has a digital readout and output for interface to peripheral equipment, e.g. printers and computer systems.

Among the advantages of the RV-8 are:

- Direct digital readout in cps thereby eliminating the need for multiplying factors.
- Easy to use and calibrate.
- No brushes or slip rings to wear out.

As is indicated by the viscosity range, the RV-8 is used in many industries, including coatings, mastics, adhesives, inks, cosmetics and food.

A number of optional extras, including temperature control unit, an output printer and small sample adaptor are also available.

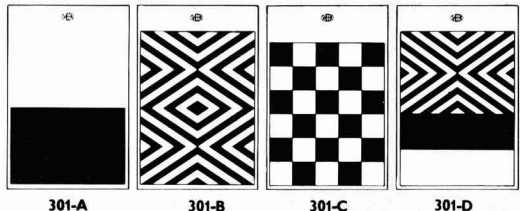


Hiding Power Charts

Sheen now offer a complete range of hiding/power/opacity charts as illustrated.

We can print any individual design or dimensional requirements – minimum 10,000 charts.

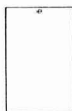
Our charts are UV cured and their lacquer is resistant to MEK. They are suitable for use with most organic, water based or solvent borne coatings.



SIZE OVERALL : 250 x 180mm COATING AREA : 350 cm²



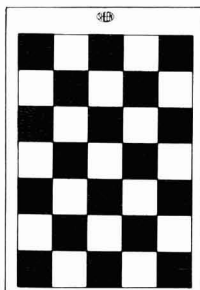
301-E



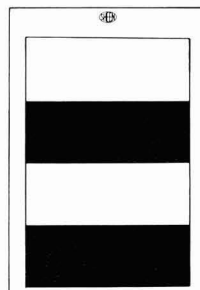
301-F
Glossy



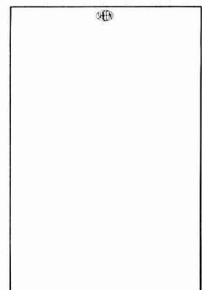
301-G
Uncoated



301-H



301-J



301-K Glossy

SIZE OVERALL : 150 x 100mm

SIZE OVERALL : 420 x 300mm (A-3) COATING AREA : 1000cm²

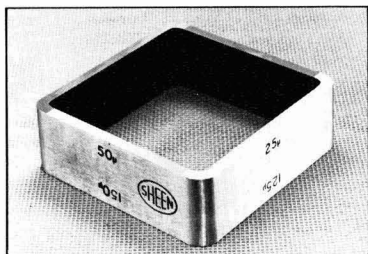
Sheen agents in conference

Photo shows Sheen overseas agents from Europe, Asia and the Americas who met in conference recently in Sussex with Sheen UK management and technical sales staff.

The latest developments in measurement techniques were discussed, together with market trends for coating thickness, gloss, opacity and other instruments. Delegates were also able to visit the Sheen subsidiary, Startronic Ltd, to see development work on some of the exciting new instruments that are just around the corner.



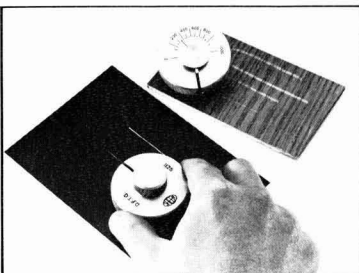
Recent additions to our product range include...



MULTI FILM APPLICATOR – REF 1114

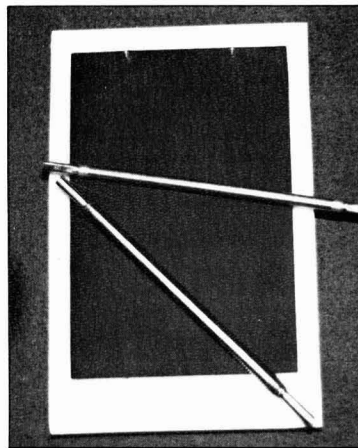
This will draw down films of up to 8 different thicknesses: 25, 50, 75, 100, 125, 150, 175 and 200 microns on one applicator.

Film width is 76mm (3 inches). Overall dimensions: 100 x 100 x 30mm. Weight: 475 grams.



DRY FILM THICKNESS GAUGE – REF 1125

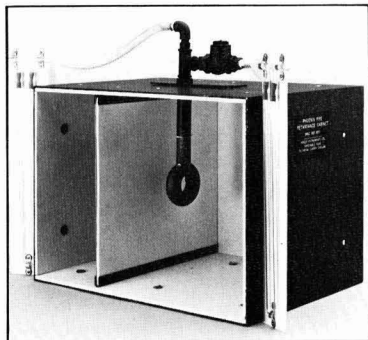
Very simple but accurate gauge to measure any organic coating thickness on solid substrates including wood. Measures in range of 0-250 or 0-1000 microns.



WIRE BAR COATERS – REF 1120

These stainless steel wire wound bar applicators for paints, inks and adhesives, give coating widths of 18 or 25cm. Wet film thicknesses are: 10, 15, 25, 35, 50, 75, 100, 125, 150 and 200 microns.

Available individually or in boxed sets of ten including impression bed.



PHOENIX CABINET – REF 1053

For checking fire retardance properties of coatings.



MINI PORTABLE Ph METER

Extremely light-weight (160 gms), battery operated, hand-held. Displays results on easy-to-read 13mm liquid crystal display. Full range of accessories available.

Sheen

INSTRUMENTS

Sheen Instruments Ltd
Sheendale Road, Richmond, Surrey,
England TW9 2JL
Tel: 01-940 0233/1717 Telex: 268281

Think of Surface Coating Testing... Think of Sheen

not sufficiently responsive to the microwave field. Microwave drying will produce volume heating in sufficiently 'lossy' inks by virtue of the penetration effects and stimulation of polar molecules (glycols, alcohols and water). In an evaporative process the solvent molecules are volatilised through the film rather than initially at the surface as in conventional hot air drying. More uniform heating produces less chance of surface hardening thereby trapping residual solvent in the films. More compact microwave equipment than that used for the web offset drying project would be required for use on flexographic or gravure presses. There has been considerable success with less expensive, more compact radio frequency dielectric dryers which operate at lower radio frequencies, for example, 27 MHz. These have been used to dry water-based coatings and adhesives on printed papers and boards. A recent development of a dryer system combines the volumetric heating of radio frequency energy with the convective drying from high velocity air float dryers¹⁸. This technique should be very attractive for drying thick aqueous coatings on fast moving paper and plastic webs.

The future

There is likely to be more commercial progress in water-based flexographic and gravure inks for paper and board substrates used in packaging and studies on flexographic inks for newspaper printing. A better understanding of ink and substrate relationships and improvements in drying techniques will help to advance progress generally. New and improved resin systems are needed for inks to print impermeable substrates. More attention could be given to investigating agricultural sources for the synthesis of novel polymers as alternatives to petro-chemical derivatives. Closer co-operation of the printing ink and allied industries, printers, converters, paper and board manufacturers and designers of presses and drying equipment should yield fruitful results.

Acknowledgements

The author wishes to acknowledge the help of his former colleague Dr M. R. Harrison for advice and comments during the preparation of this paper and to thank the Directors of Croda Polymers International Ltd. for permission to publish.

[Received 4 February 1985]

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conference discussions

Discussion is encouraged at OCCA Conferences following the presentation of papers. Those who put questions were asked to fill in discussion slips with the details of their questions. Edited versions of the discussions that followed of the papers published in the **November 1985** issue appear below: questions in ordinary roman type, answered in italic. Only those questions for which discussion slips were received are published.

Internal stress and film formation in emulsion paints

D. Y. Perera

W. FUNKE: Is it possible to measure the regain of an internal stress after a transient increase of temperature above T_g and relate this to the film structure?

D. Y. PERERA: *Yes, certainly. We have carried out these types of experiments and the results will be published in the near future. The apparatus shown in Figure 1 was especially designed for this purpose. It enables one to determine the stress as a function of temperature (between $\approx -15^\circ\text{C}$ and $\approx 80^\circ\text{C}$ at various relative humidities) and thus, to evaluate hygrothermal stresses, T_g at different relative humidities, relaxation/relief processes, etc, all characteristics dependent on coating structure or composition.*

A. SAARNAK: We have made extensive determination of

temperature induced stresses in coatings and found high stress levels when the temperature goes down. This indicates that outdoor paints can be exposed to high stresses during the cold season. Furthermore fluctuating temperatures can induce stress variation leading to a kind of fatigue. This must be considered when formulating paints for outdoor use?

D. Y. PERERA: *Indeed, considerable high hygrothermal stresses (tensile stresses) can develop at low temperatures and relative humidities (i.e. winter conditions for most European countries). These stresses can now be easily determined (e.g. by using the Stressmeter apparatus, shown in Figure 1) and should certainly be taken into consideration in predicting the coating durability.*

C. SAILLOUR: Correlation between measurements of internal stresses of films and measurements of adhesion between the organic film and the substrate?

D. Y. PERERA: *There is already a lot of work done in this field (see for example in references 8 and 29).*

Probably, the mathematical equation describing this correlation in the clearest way is: $\gamma = sc\epsilon$.

This relationship indicates that the larger the values of S (internal stress), c (thickness of the coating) and ϵ (internal strain) the higher the coating tendency to detach from its substrate ($\gamma = \text{interfacial work of adhesion}$).

C. G. CRAWFORTH: Have you looked at the effect of

blends of coalescing solvents on the relationship between stress and time? Is it proportioned to concentration of individual components?

D. Y. PERRERA: *No, we have not looked at this problem in particular. It is certainly an important subject to be investigated by a paint chemist formulating emulsion paints. This can easily be made by using the techniques described in this paper.*

The development of internal stress (rate and magnitude) will probably be affected by the way the concentration of individual components will influence the evaporation process and the plasticizing effectiveness of the blend of coalescents.

The adhesion of chlorinated rubber to mild steel using a blister technique

Ali Elbasir, J. D. Scantlebury and L. M. Callow

R. L. J. MORRIS: Have you tried stopping the gas supply after reaching a steady state and thus determine the limiting pressure for growth of the blisters or, otherwise sought to determine the minimum pressure for blister growth?

J. D. SCANTLEBURY: *This is an interesting and useful suggestion which we will take up.*

W. FUNKE: Conditions on measurement of wet adhesion by your methods are different from the actual conditions existing in corrosion of coated metals. Neglecting mechanical effects, absorption of water with respect to mineral oil may account for differences in measured values for adhesion.

J. D. SCANTLEBURY: *The rate of water absorption of our coatings is substantially slower than the speed with which we carry out our measurements.*

C. G. CRAWFORTH: Has Dr Scantlebury investigated the use of PROHESION^(R) equipment in the work?

J. D. SCANTLEBURY: *Not yet, but we intend to do so.*

G. C. FETTIS: Could your technique be used with substrates other than metal, e.g. wood?

J. D. SCANTLEBURY: *With suitable modifications to the hole in the substrate to prevent the fluid being forced into the wood, there is no obvious reason why our technique should not be suitable for wood.*

H. G. STEPHENS: Opinion, rather than question. The oil hydraulic dilutes the hydrogen bonding interlayer of Prof. Funke's concept breaking the bond early. Water reinforces the HB interlayer delaying the breaking of the bond.

J. D. SCANTLEBURY: *This is an interesting possible model of the atomic processes occurring.*

Infrared studies of surface species on insoluble inorganic oxide particles immersed in liquids

C. H. Rochester

L. VALENTINE: Have your experiments so far included pigments and solvents with "normal" i.e. commercial levels of water or water vapour, and do these show significant difference from dry materials?

C. H. ROCHESTER: *No. We have not carried out experiments in which the solvent phase has been deliberately saturated with water or water vapour. However, we have studied adsorption from aprotic solvents on to surfaces*

which have differed in their initial degree of hydration. The results shown in Figure 10 represent one example and show that there is a difference in behaviour depending upon the degree of hydroxylation of the surface. It is probable that for solvents saturated with water the experimental results will differ to some extent from corresponding results for completely anhydrous systems.

J. D. SCANTLEBURY: How does the theory of acid-base interaction relate to your study?

C. H. ROCHESTER: *In some systems which we have studied particularly using tertiary amines as adsorbates evidence for Brønsted acidity of surface hydroxyle groups has been observed in the infrared spectra. Bands characteristic of substituted quaternary ammonium ions are observed when proton transfer from an oxide surface to a tertiary amine takes place. Papers in which this behaviour has been reported include: J. Chem. Soc., Faraday Trans 1, 1980, 76, 1158; and J. Colloid Interface Sci., 1982, 89, 202.*

P. J. MOLES: Can this IR technique be used to help characterise the surface of plastics (i.e. measure the degree of carboxylation and hydroxylation on the surface of substrates such as polyethylene and polypropylene)?

C. H. ROCHESTER: *As far as I know there has been no direct work concerned with characterising surface groups or surface-adsorbate interactions at the interface between plastic materials and a liquid phase. However, with the advent of Fourier transform infrared spectroscopic techniques in conjunction with reflectance spectroscopy it may well be worth*

exploring the application of infrared methods to the study of polymer surfaces.

T. ENTWISTLE: You have used the technique for the examination of rutile, silica and alumina surfaces. Has it been used for titanium dioxide pigments which have coatings of silica and alumina on their surfaces?

C. H. ROCHESTER: *Yes, some time ago we made some studies of adsorption from solution on to the surface of rutile pigment material which was coated with silica. The results showed that the outer surface of the coated pigment behaved in a way which was typical of silica surfaces rather than rutile surfaces. However, in contrast we have also carried out some experiments in which we have modified a surface of titania by repeated treatments with silicon tetrachloride and water in an attempt to build up a silica layer on the surface. The infrared results (J. Chem. Soc. Faraday Trans 1, 1972, 68, 17) showed that the behaviour of the modified surface differed from the separate behaviours of both silica and rutile. In particular the modified surface exhibited significant Brønsted acidity in the presence of adsorbed pyridine.*

occa meetings

Thames Valley Section

Use of surface coatings and fire protection

The first lecture of the Thames Valley section was held on Thursday, 19 September 1985 at The Crown Hotel, Amersham. Members and guests heard Mr Frank Adams give a talk entitled, "Use of Surface Coatings and Fire Protection".

Mr Adams commenced by outlining the involvement of government and insurance industry in fire protection, leading to the situation as it is today with the Fire Research Station, a government establishment within the Department of Environment. The Fire Research Station is an advisory authority only, the testing facilities are now in the hands of a few commercial research establishments.

He continued with a description of cause and effects of fire; fire initiation; smoke and hot gases; flame spread and downward radiation, leading to the flash-over point when all combustibles become ignited leading to the fully developed fire.

The lecture then covered aspects of current legislation – the roles played by interested parties such as the Building and Research Establishment, the insurance industry, the Greater London Council, and the marine and petroleum industries.

The subject of fire protection was discussed, the speaker outlined the role played by passive and active materials and a definition was given for both categories. Active materials

and systems were then discussed in more detail, identifying such groups as intumescent, ablatives and sublimates.

Finally, a demonstration of the effects of fire on a wide range of systems offering fire protection was given.

After a question and answer period, a vote of thanks was proposed by the Chairman, Mr Alan Fell.

J. A. Gant

Newcastle Section

Deterioration and protection of exterior wood

Thirty-two members attended the first meeting of the 1985/6 session to hear Dr Roy Miller (Building Research Establishment) give a lecture on the "Deterioration and protection of exterior wood". Conventional non-lead coatings have proven incapable of overcoming general poor building practices over the last 30 years and the UK spends £300 million each year in wood maintenance. Some local authorities, in desperation, have resorted to replacing painted wood with plastic materials.

Against this background Dr Miller reviewed the structure of wood and the factors relevant to protection needs – surface porosity, permeability, hygroscopicity, dimensional instability etc. Heartwood is no longer available in quantity and the less durable sapwood-rich timbers are used; these take up moisture rapidly and are easily degraded by UV/visible light.

The effects of blue stain fungus-disfigurement and paint breakdown-necessitates wide spectrum fungal resistance of subsequent coating systems. Breakdown of surface wood layers by daylight renders clear coatings generally poor and semi-transparent stains are not completely successful in preventing photodegradation. Thin wood strip tests at BRE show that, although UV absorbers improve clear finishes, opaque coatings are best.

Window frame and joint testing at BRE have shown the necessity to seal end grain before glueing and for special glazing where stains or water-based acrylics are used.

Dr Miller summarised the requirements for wood protection systems, such as good adhesion, weatherability, extensibility, moisture permeability and mould resistance. Wood stains do not flake and are easily maintained, but they darken and do not prevent excessive wood movement. Opaque alkyd systems lack aged flexibility with most current building methods. On balance, acrylics offer best performance of all if full factory finishing is adopted.

The vote of thanks for an extremely interesting and well presented lecture was given by the Chairman, Mr G. D. Carr.

J. Bravey

Manchester Section

Exploiting the PU Potential

On Monday, 7 October 1985, 64 members and guests of the Manchester Section were present at a lecture entitled, "Exploiting the PU Potential". The lecture at the Manchester Club, was presented by Mr A. C. Jolly, OCCA, Vice President and former Manchester Section Chairman.

The first part of this lecture reviewed the areas in which polyurethanes have already become established such as paints, foams, textile coatings, adhesives, sealants, encapsulating resins and floorings, and that the chemistry of polyurethanes was such that systems could be tailor-made for any particular requirement. The industry has now matured, and should be looking to consolidate these old markets, and be looking to expand into new areas.

One of the main problems of the PU Industry relates to the Health and Safety regulations. It is difficult to measure isocyanate levels quickly and easily. Medical symptoms are difficult to deal with, and asthma attacks due to isocyanate may occur some time after the original exposure incident. Indications are that handled properly the risk of cancer with isocyanate materials is very low. To conclude, it can be said that there are no dangerous chemicals, only dangerous methods of handling them.

Summarising the areas where new products are becoming available, as regards isocyanates, there are very few new products, and these are of the aliphatic type, which will be

of most use to the paint industry. By contrast, however, there is a considerable amount of research into new polyols in order to improve and widen the scope of PU systems. New types of materials could fall into the following categories: High solids and water based (as a way round solvent emission regulations), and uv curing in combination with acrylics.

The final part of the lecture, illustrated with slides, dealt with the various uses that PU systems were being put to, most of the examples being of the moisture curing type. It was emphasised, that for satisfactory results, it was essential that there was good surface preparation. For this it was necessary to know how the substrate had been treated previously, and also what surface contaminants could be present, in order that surface preparation could be correctly carried out.

The lecture was followed by a lively question-time, and a vote of thanks was proposed by John Calderbank.

M. G. Langdon

London Section

The Best of British

The first technical session of the 1985/86 season was held on Thursday, 19 September at the popular and now regular venue of the Pearly King at Bow.

The speaker, Dr Leslie Valentine of Berger, Jenson and Nicholson group, presented his paper "The Best of British" which he had first given as guest speaker to the Scandinavian Federation of Societies of Paint Technology in May 1984. In his paper Dr Valentine detailed a number of current research and development projects undertaken by the British paint industry.

Specific examples included research work on emulsion polymerisation which after being pursued to an interesting stage was dropped due to "cut backs". A British company took up the option on the research and followed it through to a commercial conclusion as the "Loop Process" with various interesting technical "spin offs".

A multitude of other interesting examples were cited including work on measuring flocculation in dry paint films, anti-corrosive paint testing and ion exchange anti-corrosive pigments.

Finally, the work carried out by ICI Paints Division on improving the safety of aviation fuel was given as an illustration of the possibility of paint technology and "know how" being able to solve problems in other industries.

The evening was concluded by a question and answer session with a vote of thanks for this novel and interesting lecture being proposed by Mr Ron Gough.

Peter Neal

Wet Adhesion

Sir,

I have read with great interest the paper by W. Funke in a recent issue of *JCOCA* (69 (9), 229-232) as it covers an aspect of surface coatings technology on which I have worked for several years viz: adhesion aspects of organic coatings.

I do not propose to quarrel with the implied general conclusions of the paper that wet adhesion is an important property of coatings and that any improvement in this property is highly desirable, as I have made similar statements in the past, I would however like to correct a point of fact, draw the attention of the author to other literature references pertinent to the subject and present other points for debate.

Testing of wet adhesion

Contrary to the author's statement that adhesion data in the literature regarding the influence of water are mostly ambiguous as it is not clear whether the respective measurements have been actually performed in the wet state, whereas earlier work published⁵ is totally unambiguous. The experimental methods and techniques are clearly stated and the use of a fast curing cyanoacrylate adhesive described so that the minimum time elapsed between bonding and pulling the specimens in order to minimise desorption. The point was made that some slight recovery of adhesion was inevitable although it is unlikely that the specimens could desorb to any great degree in the bonded condition in the time scale of the experiment.

Both the "direct pull-off" and the "torque spanner test"¹ are suitable for the measurement of wet adhesion if a high strength rapid cure adhesive is used, both methods have the major advantage over the tape test that they provide quantitative data rather than the qualitative observations provided by the latter test, particularly if the rate of loss of adhesion is being studied.

Pertinent references

In addition to the references quoted, may I draw the attention of the author to the following papers which I feel are germane to any discussion of wet adhesion.

- The Effect of Water on the Adhesion of Surface Coatings².
- The Effect of Sea Water on the Adhesion of Surface Coatings³.
- Long Term Adhesion Studies on Multicoat Systems Exposed to Natural Weathering⁴.
- The Adhesion of Multicoat Systems After Nine Years Exposure⁵.
- The Use of Organo-Silanes as Adhesion Promoters for Organic coatings⁶.
- Organo-Silanes as Adhesion Promoters for Organic coatings - Part 1⁷, Part 2⁸, Part 4⁹ and Part 5¹⁰.

In the papers quoted data on wet adhesion are presented on paint systems ranging from single coats of epoxides, polyurethanes, chlorinated rubber and alkyds to multicoat systems of many different generic types representing most cure mechanisms and on a variety of substrates. In several of the investigations reported the experimental method was to cure the bonded wet specimens in water saturated air to eliminate drying out, the data therefore is on wet adhesion. In published work⁴⁻⁵ the specimens were bonded, cured and tested in the actual test environment.

Points for debate

From my own work I have reported data on the wet adhesion of single and multiple coats of chemically cured systems (epoxide and polyurethane), oxidative cure (alkyds, oleoresinous and styrenated alkyds), solvent evaporative (chlorinated rubber, styrene butadiene and vinyl) and thermosets (acrylic and melamine/epoxide). This must be considered to be a representative range and would seem to indicate that most, if not all, conventional coatings, loose adhesion under water soaked conditions, ie, loss of adhesion due to water ingress is a universal phenomena. If this is accepted, it would be reasonable to look for a correlation between the wet adhesion characteristics of coatings and the anti-corrosion protection they afford to the substrate. If high wet adhesion is of paramount importance rather than a desirable property then it might be expected that those coatings showing the highest wet adhesion would provide the greatest protection and as a corollary that coating systems, having the lowest wet adhesion would provide the least. Does the evidence support this thesis?

In an earlier work² it is concluded that no real correlation between adhesion behaviour and corrosion resistance exists; thus of the three coatings showing the highest corrosion resistance, the thermosetting acrylic, polyamide cured epoxide and the polyurethane, two of these showed the lowest adhesion on water immersion. This was particularly true of the polyurethane paint which showed almost parallel adhesion behaviour to the long oil alkyd paint which was the worst of the nine coatings for corrosion resistance. The short oil epoxide ester paint showed excellent adhesion characteristics (ie, high wet adhesion) being very similar in behaviour to the thermosetting acrylic, but showed only moderate corrosion resistance. The three solvent drying systems were intermediate in both corrosion resistance and adhesion behaviour.

In another report⁴ it is shown that although the adhesion of nine multi-coat systems fluctuated widely and wildly over a period of four years natural exposure, none of the substrates showed corrosion. The report on the completion of this investigation after nine years natural exposure⁵ showed that of the nine systems tested on mild steel substrates only a polyamide cured epoxide showed corrosion of the substrate after this lengthy exposure

period. There was no evidence that the wet adhesion of this particular system showed any lesser variation over the period of exposure and (in fact the final recovered adhesion was greater than the original) than any other system, all of which were free from corrosion. The final conclusion from this experiment was that major variations in adhesion caused by environment did not lead to a progressive deterioration in the recovered adhesion, nor did these variations cause a deterioration in the protective properties of the paint systems.

If we now consider the question of the site of failure when measuring wet adhesion, the author states that "contrary to dry adhesion failure, wet adhesion failure is usually an adhesive one, as water interacts with the polar forces in the coating/metal interface". This statement obviously recognises that adhesion failure is not an invariable occurrence under water soaked conditions. Evidence for this is supplied by previous work⁶, where it is shown that with both two pack epoxide and polyurethane paints the wet adhesion site of failure was within an unpigmented layer of the coating, it being inferred that this unpigmented layer was at least 74-92 Å thick and that the residual layer was at least 37-46 Å thick. The general problem is that hard evidence is lacking and many literature statements, which claim adhesion failures are probably best interpreted in terms of "apparent" adhesion failure. In this respect I must plead guilty as charged.

Information on the actual site of failure is probably essential to any real understanding of the mechanism of failure and its bearing on corrosion protection.

Interpretation of sites of failure is difficult and I can only refer the reader to a recent publication on the subject¹¹. Certainly a great deal more careful study is required before it can be said with certainty that wet adhesion failure is usually adhesive. As previously stated the generation of this information is central to any meaningful discussion on the role of adhesion in corrosion protection.

Wet adhesion is not just a laboratory curiosity. In service some paint systems spend most of their time in water soaked conditions, e.g. ships paints, tank linings, etc, and many others operate under conditions of intermittent water soaking, eg. cars, structural steel, pond linings etc, without evidence of widespread adhesion or corrosion failure for long periods. Further, they are frequently exposed to a diurnal temperature cycle and high temperature excursion factors known to cause rapid loss of adhesion under water soaked conditions. It is perhaps fair to say that most corrosion failures occur due to poor surface preparation, inadequate coating thickness, poor application conditions or the wrong choice of coating system. Complete breakdown is the exception rather than the rule. This is in spite of the known loss of adhesion; practical experience is what counts.

The author has suggested possible methods of improving the wet adhesion of coating systems, but I feel that there is a notable omission; that of the use of adhesion promoters. One such group of materials is the organo-silanes which have been recently reported in some detail⁹⁻¹⁰. This study

indicates that the use of organo-silanes of the general formula R-Si (OR)¹, with epoxide and polyurethane paints can produce a dramatic increase in both the wet and recovered adhesion. Improvements in wet adhesion up to 800 per cent have been recorded although 200-400 per cent is more usual. Other adhesion promoters are titanium¹² and zirconium chemicals¹³. I feel that this particular method of improving the wet adhesion is relatively simple, low technology and extremely effective as it may be applied to a wide range of conventional coating systems.

If it is accepted that most if not all conventional organic coatings undergo a loss of adhesion under water soaked conditions whether this loss be real or apparent, and in spite of this loss in adhesion, corrosion does not invariably occur, is it not reasonable to regard the loss of adhesion and the onset of corrosion as two *separate* and not necessarily related phenomena? Support for this is given by the reported experimental facts that show that loss of adhesion occurs rapidly, often within hours of exposure to wet environments, although corrosion may not occur within nine years or longer; surely if wet adhesion is the most important and decisive property as stated, a much shorter time interval between adhesion loss and corrosion of the substrate would be expected. The argument does not apply in the situation where complete detachment of the paint film has occurred. It seems a doubtful argument to make this unqualified statement as a fundamental truth and from this infer that the protection afforded by some "excellent commercial anti-corrosive coating systems which do not have low permeabilities can only be explained by good wet adhesion properties". Many other formulation aspects and chemico-physical properties are likely to be involved.

My own view of adhesion is that of a property which varies widely with the service environmental conditions and it must be concluded that in practice only a minimum adhesion greater than the forces imposed upon the coating by external agencies is essential, and this is of comparatively low order when compared with the initial adhesion. Further, the adhesion of any given coating can only be considered to be just one factor in the mechanism of protection of that coating, and this factor may only be a minor one. This is not to say that improvements in wet adhesion are either unnecessary or undesirable.

I hope this contribution may lead to further correspondence on the subject.

Atomic Weapons Research
Establishment,
Building SB43, Aldermaston,
Reading RG7 4PR.

Yours faithfully
P. Walker

3 October 1985

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news

SURFEX 86

A sellout

With the recent addition of ICI (Organics) and 3M to the lengthy list of exhibitors at Surfex 86 (printed in the November issue) there is now no further space left at the OCCA exhibition to be held at Harrogate in May 1986. Space has now been fully taken up in the reception and gallery areas as well as hospitality suites in the adjoining International Hotel.

Admission to this new concept exhibition for the surface coatings industries, is free, and the *Official Guide* will be available with the April 1986 issue of *JOCCA*. The guide will also be freely available at the entrance to the exhibition.

The exhibition will be open from 9 a.m. to 6 p.m. on Wednesday 14 May and from 9 a.m. to 5 p.m. on Thursday 15 May.

For enquiries regarding advertising in the guide please fill in the reader enquiry form.

Reader Enquiry Service No. 30

Ransburg-Gema opens new experimental powder-coating facility

Ransburg-Gema have opened a new experimental powder-coating laboratory at Ransburg House, Hamm Moor Lane, Weybridge.

The company has set up what is, in effect, a pilot installation designed to meet the great majority of powder-coating trial needs. The equipment comprises a GEMA MFR booth capable of accepting a work-piece up to 5ft. x 3ft. in size. Its overhead conveyor and gas-fired box oven complements the installation, so that finished

quality is instantly available for inspection and testing.

The spray booth is equipped for both manual and automatic coating so as to be able to simulate a variety of production conditions. In addition to this working installation, the laboratory is furnished with a comprehensive range of GEMA powder guns and control units.

The advantages of powder coating are becoming more widely known and appreciated. The new Ransburg-Gema laboratory has been opened in response to increasing demand and interest on the part of manufacturers. Inquiries are invited and demonstrations can be arranged at short notice.

Reader Enquiry Service No. 31

Manville to expand Spanish diatomite operation

Manville International and Mining Group, a subsidiary of the Denver-based Manville Corporation, has announced expansion plans for its diatomite mining and production operations in Alicante, Spain.

"We are pleased to tell our customers that we will be expanding the Alicante facilities and substantially increasing production in order to meet increased demand for our diatomite products in the European market", said J. P. Cashman, Manville International president.

Mr Cashman said the expansion will begin immediately and that the increased production volume would be available to customers "some time in 1986".

Manville is the world's largest producer of diatomite, a mineral used as a filter aid and filler by wine, beer, soft drink, food, paint, pharmaceutical and other industries.

The company operates diatomite mines and plants in Lompoc, California, Murat, France, Lake Myvatn, Iceland; and

Naucalpan, Mexico, in addition to its Alicante operation.

Manville International and Mining Group also has responsibility for widely diversified manufacturing operations in Europe, North America, the Far East and Latin America.

Manville Corporation, headquartered in Denver, Colorado - USA, is a diversified, international manufacturing and natural resources company with primary businesses in insulation, forest products, roofing and mining.

Reader Enquiry Service No. 32

Hoechst sponsors major art exhibition and brings out new catalogue

Hoechst UK is one of the companies sponsoring the major exhibition: "German Art in the Twentieth Century", at the Royal Academy of Arts, Piccadilly, London, from 11 October until 22 December, 1985.

Hoechst's calendar has reproduced some of the world's most important paintings since it was first published in 1951. Around one million copies are now produced each year. Printed in nine languages, including Japanese and Russian, Hoechst calendars are distributed in 110 countries and have won several international awards.

The Hoechst calendar has proved popular with admirers of "old masters" and contemporary artists alike. Each month offers a choice of paintings from national museums which, over the years, have included the National Galleries of Washington, Madrid, Moscow, Tokyo and London, amongst others.

For the 1986 calendar, Hoechst went to Paris - to the Louvre, the Musée du Jeu de Paume and the Musée National d'Art Moderne, Centre George Pompidou. Printed in full colour using Hoechst's Oza-sol® plates and other Hoechst products and

processes, the calendar includes, for example, paintings by Clouet, David, Velázquez, Vermeer, Watteau and Raphael. The Impressionists and contemporary artists are represented by Manet, Sisley, Renoir, Cézanne, Monet, Gauguin, Degas, Picasso and others. Altogether there are 25 major paintings reproduced in the Hoechst 1986 calendar.

Reader Enquiry Service No. 33

products

Speciality monomers

BP Chemicals has introduced two speciality monomers, Bisomer PPM5S and Bisomer PPM6E, designed specifically for the surface coatings industry.

Polymer systems based on Bisomer PPM5S are claimed to be suitable for a wide variety of applications including metal stoving lacquers and automotive refinish paints. Bisomer PPM5S is said to be particularly useful as a means of improving film flexibility in thermosetting acrylic surface coatings. Bisomer PPM6E has been designed as a highly efficient plasticising comonomer for use in emulsion systems.

Bisomer PPM5S has been developed as a speciality monomer, introducing both internal plasticisation and reactive functionality to solvent-based polymer systems. As it contains a terminal hydroxyl group, derived polymers are readily cross-linked using conventional systems (e.g. diisocyanates, methoxy-melamines, etc.)

Bisomer PPM6E has an effective glass transition temperature considerably less than -100°C , and is therefore a very effective "soft" monomer. It is particularly advantageous in vinyl acetate-based emulsion paint systems. For example, a 94/6 weight per weight vinyl acetate/Bisomer PPM6E copolymer offers alkali resistance, film flexibility and minimum film-forming temperature comparable to an 80:20 vinyl acetate/vinyl versatate emulsion.

Reader Enquiry Service No. 34

Drum Roller – keeping paint ready for production

Graco UK Ltd, the Wolverhampton-based fluids handling and finishing specialists, have introduced a new Drum Roller which

is designed to speed production and increase quality in any finishing process.

One of the problems associated with storage of paints and other coating materials is that of pigment separation and solids settlement. Paint is normally stored in 25- or 205-litre drums, usually in a stock area adjacent to the paint mix room. These stocks can remain there for lengthy periods of time, with the result that pigments and other solids can settle during storage, causing inconsistent quality if added to the paint system in this form. It is therefore essential to re-mix the contents of the drum before they are added to the main supply line.

The Drum Roller is said to be designed to overcome this problem. A very simple piece of equipment powered by an electric motor, the 25- or 205-litre drum is placed upon a series of rollers which rotate the drum slowly, and gradually re-mix the contents. It can therefore be positioned adjacent to or in the mix room area, and where usage of paint is high. A number of Graco Drum Rollers can be used in tandem, ready to feed the production line.

Reader Enquiry Service No. 35

New line of bonding copolymers

Essochem affiliates throughout Europe have launched the first family of products in the Company's new line of bonding copolymers. Sold under Essochem's new ESCOR trademark, this line of speciality products aims to satisfy a wide variety of multilayer plastic bonding needs. The line encompasses a number of different grades that build upon Essochem's technology strengths in molecular tailoring of polymers for specific end-uses.

The initial 'TR' series is designed for high performance polyethylene extrusion coating and coextrusion applications where adhesion to aluminium foil, nylon and other substrates is important. "Companies participating in the revolution in multilayer packaging films and composites should look at this family of ESCOR products", said James P. Harris, Manager of Essochem's performance packaging business. "ESCOR's high adhesion and hot tack, combined with low levels of odour, off-taste, and heat-seal temperatures make a real contribution in food and consumer packaging. The resins have been tailored to reduce costs by permitting the fabricator to operate at high line speeds and reduce the amount of adhesive and structural resins incorporated.

"Outstanding product characteristics tell

only part of the story on how the ESCOR line benefits the packaging industry", Mr Harris continued. "The products are manufactured at our facilities in Europe, enhancing supply reliability versus imported products. This also permits tailoring new grades for specific European customers and end-uses", he concluded. Recently published literature on these products is now available from Essochem affiliates throughout Europe.

Essochem's performance packaging group is part of the Company's Commercial Development Europe (CDE) Division. Under the leadership of its Vice-President Urban Jacobsson, CDE is now being established to identify and develop new business opportunities in the overall polymers field.

"Our performance packaging group's venture into ESCOR bonding copolymers is the first of a whole series of new activities to be launched by CDE", Mr Jacobsson said. "We plan to establish more of these industry oriented groups with the objective of gaining in-depth understanding of end-user needs. This will enable us to provide the right technology, products and services required by that industry. To ensure worldwide capability, Exxon Chemical is also setting up parallel organisations in other parts of the world", Mr Jacobsson concluded.

Reader Enquiry Service No. 36

PPG launch OEM LINE

Many refinishing systems claim to be close to the original finish. Now, from Birmingham based PPG Industries (UK) Ltd, comes the introduction of a new product line that, it is said, can really justify this claim because, in fact, it is the same material.

OEM LINE is launched with a range of Austin Rover basecoat colours, as supplied to the paint shop for the Maestro and Montego at Austin Rover Group, Cowley, and modified to allow low baking or air drying.

This high quality, high value repair material gives Austin Rover warranty bodyshops a straightforward colour match, virtually eliminating any chance of human error such as can occur in paint mixing.

Designed to be used in association with other parts of the Austin Rover Warranty approved system, OEM LINE is compatible with Acryline primers and Acryline Clear Lacquer.

OEM LINE is available in eight colours –



The OEM line

Zircon Blue, Opaline, Oporto, Silver Leaf, Moonraker and Cashmere plus the two new Austin Rover colours, Azure Blue and Silk Green.

The introduction of the OEM LINE is a result of PPG's position as supplier of the complete paint system for the Austin Rover Maestro and Montego and is said to be an illustration of the company's strength from original finish through to refinish.

Reader Enquiry Service No. 37

New micronised polyethylene wax

Micro Powders, Inc., U.S.A., are introducing a new micronised polyethylene wax for solvent flexo and gravure inks. The

high melting point material is designed to increase abrasion resistance and anti blocking characteristics in the solvent liquid ink systems and coatings. The high molecular weight and hardness are said to give the MPP 635 exceptionally good solvent resistance.

Micro Powders have also issued a new colour brochure giving details of all their micronised waxes including a very useful product application table with percentage additions for the different waxes in their many applications.

Floridienne UK Ltd, trading as Micro Products Co, have reduced the prices for micronised wax from the USA due to the recent recovery of the pound against the dollar.

Reader Enquiry Service No. 38

OCCA news

International Liaison

A luncheon for visiting members of the International Committee to Coordinate Activities of Technical Groups in the Coatings Industry (ICCATCI) is sponsored each year by the Federation of Societies for Coatings Technology (FSCT) at its Annual Meeting and Paint Show.

ICCATCI is composed of: FSCT; Federation of Associations of Technicians in the Paint, Varnish, Lacquer, and Printing Ink Industries of Continental Europe (FATIPEC); Oil and Colour Chemists' Association (OCCA); Oil and Colour Chemists' Association Australia (OCCA); Japan Society of Colour Material (JSCM); and Federation of Scandinavian Paint and Varnish Technologists (SLF).

London Section

National Golf tournament

Some 45 members and guests enjoyed a superb day's golf at the Canons Brook Golf Club at Harlow, Essex, on 3rd July. Despite the bad weather experienced this summer, the London Section Committee are to be congratulated on their choice of a hot and sunny day for this, now, extremely popular event.

The trophies and prizes were presented by Ken Arbuckle, London Section Chairman, after an excellent and convivial dinner, and who later asked members to note that London Section will again have the privilege of staging the event in 1986. Special thanks were offered to Alan Maddy and Barry Canterford for their support in organising the tournament.

The National Trophy was won by Tony Seabrooke as was the Valentine Cup which is the London Section Trophy. The visitors trophy was won by L. King.

A new trophy introduced this year was the David Sharp Memorial Plate, presented by Mrs Sharp for the putting competition, and was won by Don Bannington.

Finally, thanks must be given for the very generous support in terms of prizes which were forthcoming from various sections of the industry, which ensured that even the "rabbits" went home with some memento of the day.

D. Bannington



Present at the luncheon held during the 1985 Annual Meeting and Paint Show of the FSCT in St. Louis, 8 October, were: Standing (all from the FSCT): Past-President Howard Jerome, Executive Vice-President Frank J. Borrelle; Past-President A. Clarke Boyce; President-Elect William Mirick; Treasurer Carlos E. Dorris; Birmingham Club President Roland Staples; Past-President Terry Johnson; and Past-President William H. Ellis. Seated: OCCAA Past-President Ted Saultrey; FATIPEC Past-President Romeo Capanni; OCCA President Frank Redman; FSCT President Joseph A. Bauer; SLF Past-President Helge Meyer; and JSCM Vice-President Kenjiro Meguro.

professional grade register

At a meeting of the Professional Grade Committee held on 23 October 1985 the following admissions were made:

Transferred from Associateship to Fellowship

Young, Hugh (*West Riding*)
Walker, Peter (*Thames Valley*)

Admitted to Associateship

Chaudhry, Mudassar Iqbal
(*General Overseas - Pakistan*)
Tilak, Girish Yeshwant
(*General Overseas - India*)

Anyone who has allowed his membership of the Association to lapse and now desires to rejoin the Association is reminded that previous service as an Ordinary Member (or Registered Student) can be counted towards the qualifying period of membership set out in the regulations.

Candidates for the Licentiatehip are reminded that dissertations are no longer required but written evidence on a subject directly associated with surface coatings has to be submitted.

List of successful candidates

As laid down in the report of the Working Party on Education, Training and Qualifications which was adopted on the institution of the Professional Grade, a list of those members in the Grade is published in the December issue of the *Journal* each year. The 14th such list appears below and includes the names and members resident in 34 countries.

The sections to which members are attached are given in italics.

Fellows

Addenbrooke, Brian John (*Midlands*)
Aitken-Smith, Frank Joseph (*Auckland*)
Anneveldt, Jan Johan Willem
(*Transvaal*)
Apperley, Thomas William James (*West Riding*)
Arbuckel, Kenneth Harold (*London*)
Archer, Harold (*Manchester*)
Arnold, Michael Henry Miller (*London*)
Ashworth, Norman (*Manchester*)
Astfalck, Anthony Noel (*Transvaal*)
Atherton, Donald (*Scottish*)
Bailey, John Noel (*Newcastle*)
Banfield, Thomas Arthur (*London*)
Bayliss, Derek Arthur (*London*)
Bennett, Norman Arthur
(*General Overseas - Malta*)
Bester, Lawrence Percy (*Natal*)

Bhumkar, Chidanand Jayram
(*General Overseas - India*)
Birrell, Peter (*Ontario*)
Bishop, Eric Harold Abbott
(*West Riding*)
Bloomfield, Kenneth Vincent (*London*)
Bohringer, Eberhard (*London*)
Boroky, Joseph Stephen
(*General Overseas - Australia*)
Bosman, Herman Izak (*Transvaal*)
Bourne, John Robert
(*Midlands - Trent Valley Branch*)
Bridle, Peter Frederick (*London*)
Brooks, Leo James (*London*)
Brown, Arthur Ernest Girdlestone
(*London*)
Burwell, Barry (*Manchester*)
Butcher, George Alfred (*Midlands*)
Butcher, Kenneth William George
(*Manchester*)
Butler, Cecil (*West Riding*)
Caffery, George Francis (*London*)
Caldwell, David George (*Wellington*)
Campbell, George Alexander
(*Manchester*)
Carr, William (*Manchester*)
Carter, Eric Victor (*London*)
Chessman, Clifford Reginald
(*Transvaal*)
Clarke, Harry James (*Midlands*)
Clement, Donovan Harry (*Midlands*)
Colborn, Douglas Charles
(*Thames Valley*)
Cole, Derek
(*General Overseas - Australia*)
Collier, Claude William
(*Midlands - Trent Valley Branch*)
Collings, Arthur Geoffrey (*London*)
Coupe, Raymond Richard (*London*)
Courtman, Frank (*West Riding*)
Coverdale, Peter Frederick Muir
(*Midlands*)
de Jong, Jan Lauwrens (*Transvaal*)
Dowsing, George Frederick (*London*)
Draper, Patrick Albert (*Natal*)
Duligal, Eric Arthur (*Transvaal*)
Dunkley, Frederick George
(*Midlands - Trent Valley Branch*)
Durrant, George Geoffrey (*Hull*)
Easton, James Douglas
(*General Overseas - USA*)
Eglinton, Roland Alexander (*Natal*)
Entwistle, Thurston (*Newcastle*)
Field, Lawrence Edward (*Natal*)
Finn, Stanley Russell (*London*)
Froggatt, Joshua John (*London*)
Fullard, John Edward (*Transvaal*)
Furuhjelm, Viktor Henrik
(*General Overseas - Finland*)
Garratt, Peter Garth
(*General Overseas - Austria*)
Gate, Peter Atholl Jackson (*Transvaal*)
Geddes, Kenneth Raymond
(*Manchester*)
Giesen, Mathias Franz
(*General Overseas - Germany*)
Gillan, James Graham (*Manchester*)
Gollop, Percy Lionel (*London*)
Gooch, Colin (*Wellington*)
Gosling, Harry (*Manchester*)
Goyal, Ramkumar Bhanwarlal
(*General Overseas - India*)
Graham, Thomas (*Manchester*)
Grainger, William Alan (*Irish*)
Gray, Denis Roy (*West Riding*)
Grover, Donald Henry (*London*)
Haken, John Kingsford
(*General Overseas - Australia*)
Hamburg, Herman Rudolf (*London*)
Hanson, Robert Philip (*Newcastle*)
Hawkey, John Albert Lawrence
(*London*)
Hill, Derek Alfred Wheeler (*London*)
Hill, Gilbert Victor Geoffrey
(*Thames Valley*)
Hill, Lawrence Albert
(*General Overseas - Australia*)
Hipwood, Hubert Allan (*London*)
Hodgson, Kenneth Vickerson (*London*)
Holbrow, Gordon Leonard (*London*)
House, Dudley James (*Natal*)
Hutchinson, Geoffrey Herbert
(*Scottish - Eastern Branch*)
Inshaw, John Leslie (*Thames Valley*)
Iyengar, Doreswamy Raghavachar
(*General Overseas - USA*)
Jacob, Basil (*Thames Valley*)
Johannsen, Ralf Peter (*Cape*)
Johnsen, Svend
(*General Overseas - Denmark*)
Johnson, Roland Emanuel George
(*General Overseas - Zimbabwe Branch*)
Jolly, Anthony Charles (*Manchester*)
Jones, George Francis (*London*)
Kalewicz, Zdzislaw
(*General Overseas - France*)
Kane, Joseph Richard (*Newcastle*)
Keenan, Henry Wilfred (*London*)
King, Raymond John (*Midlands*)
Kotwal, Hoshidar Peshotan
(*General Overseas - Pakistan*)
Kut, Sigmund (*London*)
Landmann, Axel Wolfgang (*London*)
Lasser, Howard Gilbert
(*General Overseas - USA*)
Lewis, Fred (*Manchester*)
Ley, John Barry (*Thames Valley*)
Lomas, Harold (*Ontario*)
Lunt, Walter Richard (*West Riding*)
Martin, Christian Pierre
(*General Overseas - France*)
McLean, Angus (*Scottish*)
McMillan, Stanley (*Newcastle*)
McQuirk, Peter John (*London*)
Mitchell, John Edmund (*Manchester*)
Mitchell, Seward John (*Midlands*)
Monk, Cyril James Henry (*Bristol*)
Moon, William Robert (*Manchester*)
Morgans, Wilfred Morley (*London*)
Morpeth, Frederick Johnson-
(*Manchester*)
Morris, David
(*General Overseas - Nigerian Branch*)
Munn, Raymond Henry Edward-
(*London*)
Munro, Hugh Anderson (*Scottish*)
Newton, Dennis Sydney (*Bristol*)
Newton, Donald Stringer (*Bristol*)
Nutt, William Owen (*London*)
Oostens, Emile Elie Eugene
(*General Overseas - Belgium*)

professional grade register

- Parfitt, Geoffrey Derek
(*General Overseas – USA*)
- Patel, Shirish Manibhai (*Ontario*)
- Pettitt, Michael Robert (*London*)
- Pienaar, Dirk Jacobus (*Transvaal*)
- Piggott, Kenneth Elliot (*Natal*)
- Polaine, Sidney Alan (*London*)
- Porteous, Barry Milroy (*Ontario*)
- Prigmore, Maurice Henry (*Bristol*)
- Raaschou Nielsen, Hans Kristian
(*General Overseas – Denmark*)
- Rampley, Dennis Neil (*London*)
- Ray, Stanley Arthur (*Midlands*)
- Rechmann, Heinz
(*General Overseas – Germany*)
- Redman, Frank Benson (*Manchester*)
- Reid, John Rodney Stanford (*Natal*)
- Rileigh, Albert Kenneth
(*General Overseas – Australia*)
- Robson, Gordon Reginald (*Manchester*)
- Roe, David Edwin (*London*)
- Rose, Charles (*Manchester*)
- Rouse, Robert Earnshaw (*Transvaal*)
- Rubin, Wallace (*London*)
- Rudram, Arthur Thomas Stephen
(*London*)
- Saunders, Laurence Frederick
(*Transvaal*)
- Seymour, Norman Henry (*Manchester*)
- Sharpe, Eric Edward Victor (*Transvaal*)
- Sharp, Peter Frank (*Auckland*)
- Shepherd, Joseph (*Newcastle*)
- Silsby, Denys John (*Midlands*)
- Simon, Raymond (*Irish*)
- Slade, Harold Aitken (*Midlands*)
- Slinn, Thomas Walter (*Wellington*)
- Smith, Eric (*West Riding*)
- Smith, Francis Mark (*Manchester*)
- Smith, Harry (*Manchester*)
- Smith, John George Nixon (*Newcastle*)
- Sowerbutts, Frank (*London*)
- Stead, Graeme Rupert (*Transvaal*)
- Stoodley, Keith Herbert (*London*)
- Stoyle, Francis Wilbert (*Irish*)
- Stretton, Elizabeth (*Manchester*)
- Tate, Donald Howarth (*Newcastle*)
- Tatton, William Henry (*Thames Valley*)
- Tawn, Alec Richard Hornsey (*London*)
- Taylor, John Roberts (*Bristol*)
- Thukral, Prem Sagar (*London*)
- Timm, Eric Ralph (*Transvaal*)
- Tooth, John Henry Collins (*London*)
- Turner, John Harry Wallace
(*Manchester*)
- Valentine, Leslie (*London*)
- van Londen, Anton Matthijs
(*General Overseas – Netherlands*)
- Walker, Peter (*Thames Valley*)
- Wall, Dennis Charles (*Manchester*)
- Watkinson, Leonard James
(*West Riding*)
- Weineck, Terrence Graham
(*General Overseas – Portugal*)
- Westwood, George Ernest (*Hull*)
- White, Robert Arthur (*Auckland*)
- Whiteley, Peter (*Midlands*)
- Whitfield, Thomas (*Auckland*)
- Wilkinson, Thomas William (*Hull*)
- Willis, Gervase Hewitson (*Manchester*)
- Windsor, Frederick Barrv (*Manchester*)
- Wood, George (*London*)
- Woodbridge, Richard John (*Bristol*)
- Worsdall, Herbert Charles (*London*)
- Young, Hugh (*West Riding*)

Associates

- Abel, Adrian George (*West Riding*)
- Acey, John Arthur (*London*)
- Adams, John Charles (*Midlands*)
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