



MURAKAMI

Printing with **Water Base & Discharge Inks**

Stencil Making & Print Techniques



Objectives

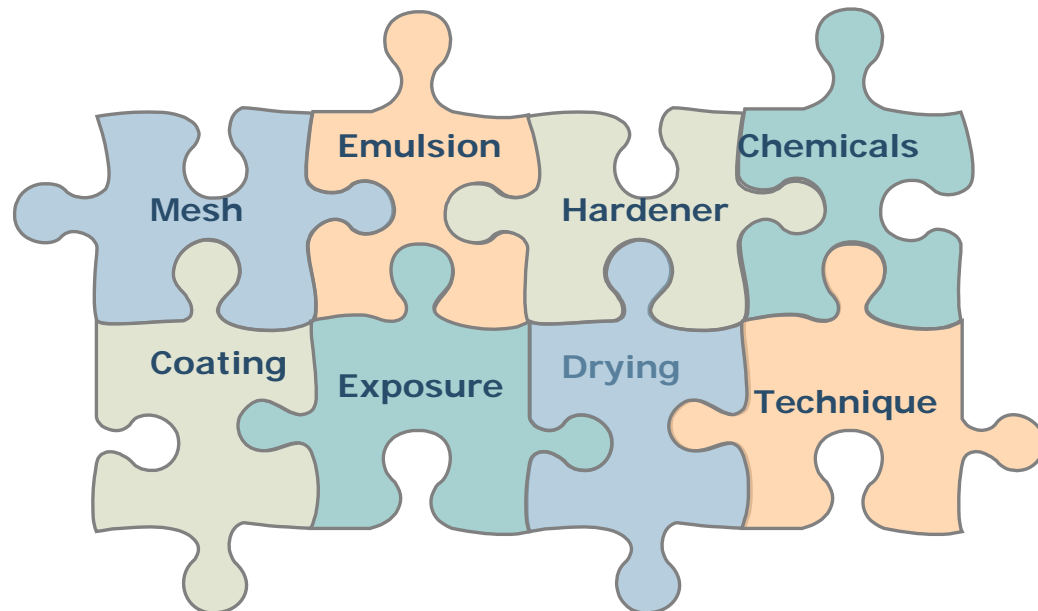
- To improve screen production performance, minimize down time, and optimize screen life by preparing durable stencils with water base screen making techniques .
- Mesh Selection for printing with water base and discharge inks.
- Understanding coating and drying techniques for water base printing.
- How the screen room and humidity affect durability.
- Lamps and exposure considerations.
- Pre-Press requirements for water base
- Print techniques for water base and discharge.
- Pending Regulations regarding ink components



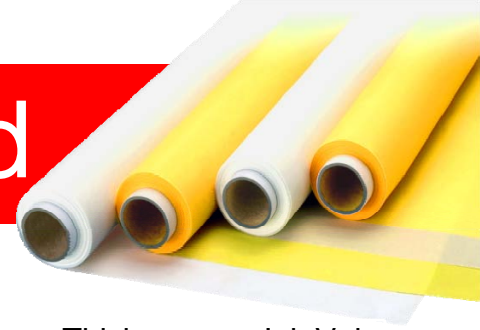
Orientation

- Water base and especially discharge inks are highly aggressive and require a durable stencil prepared with special emulsions and screen production management.
- Understand & Control the key variables to standardize processes, techniques and materials to yield the most durable stencil possible.

- ❑ **Preparing Quality Screens is the key to faster and consistent production without having to go through costly down time due to premature stencil breakdown.**



Topic 1 – Smartmesh S Thread



- Mesh selection is the first important step for making stencils.
- Water base and Discharge base inks require different types of mesh especially on roll to roll printing where S thread (noted in red) is needed for optimum ink lay down.
- Depending on the mesh count by itself is not sufficient most of the time. Looking at thread diameter, mesh openings and percentage of open area are also important.

Mesh Count (per inch)	Type	Diameter (micron)	M.O. (micron)	Open Area (%)	Thickness (micron)	Ink Vol. (cm ³ /m ²)
36	T	250	597	50	485	241
40	T	200	435	47	380	179
60	T	120	303	51	205	105
70	S	71	292	65	119	77
80	S	71	247	60	119	71
86	T	100	195	44	165	73
110	S	71	160	48	115	55
110	T	80	151	43	140	60
125	T	71	132	42	122	51
135	T	54	134	51	88	45
150	S	48	121	51	77	39
150	T	54	115	46	84	39
160	S	48	111	49	75	36
160	T	54	105	44	84	37
180	S	48	93	44	74	33
180	T	54	87	38	82	31
200	S	48	79	39	73	28
200	T	54	73	33	82	27



Quick checklist

What's happening with my screens?

Causes & Answers

Haze and ghost images left after reclaiming screen.



Haze is caused by ink locking into mesh creases. Apply HR-700, or 701 haze remover to screen. allow several minutes before using pressure washer.

Image is not washing out from the screen



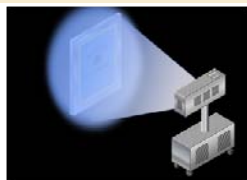
Check film, make sure film is opaque with a D-max of 3.0-4.0 If you can see through the film it is not opaque.

Screens are degreased but still shows fisheyes and air bells after emulsion coating and drying



Degrease with DGR-801. Rinse frame edges and mesh with clean water. Dry screen horizontally, coat when dry.

Screen is breaking down and melting after only a few hundred prints.



Check exposure times and age and strength of lamp. Dry emulsion completely before exposing.

Why is my screen full of pinholes?



Degrease with DGR 801 and rinse completely. Slow down coating speed, and use dull edge on scoop coater. Expose completely

Topic 2– Screen Preparation

*Clean your mesh to avoid pinholes & fisheyes and
Dry completely*

*Remove haze
or ghost
images*

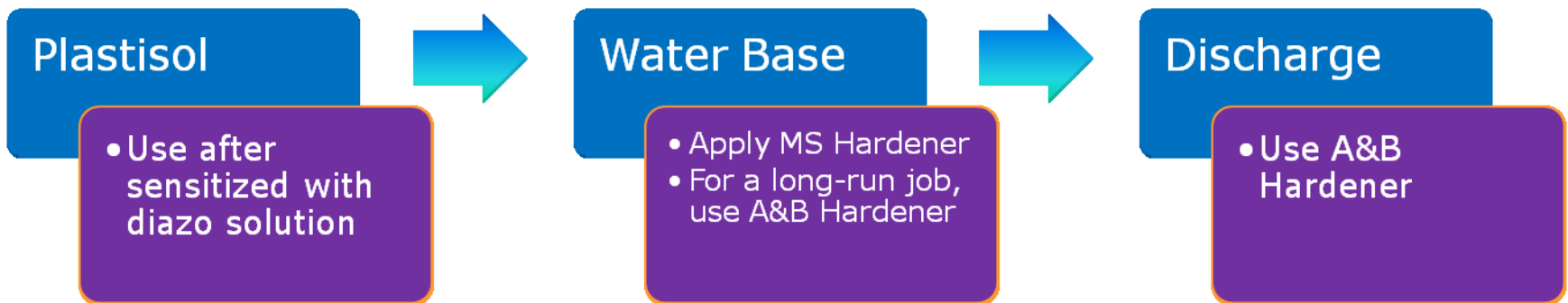
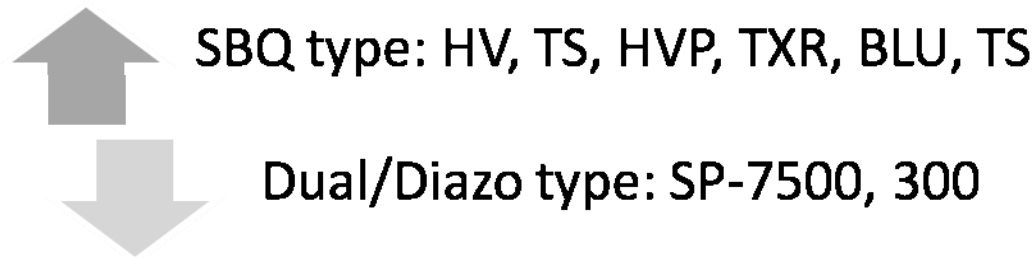
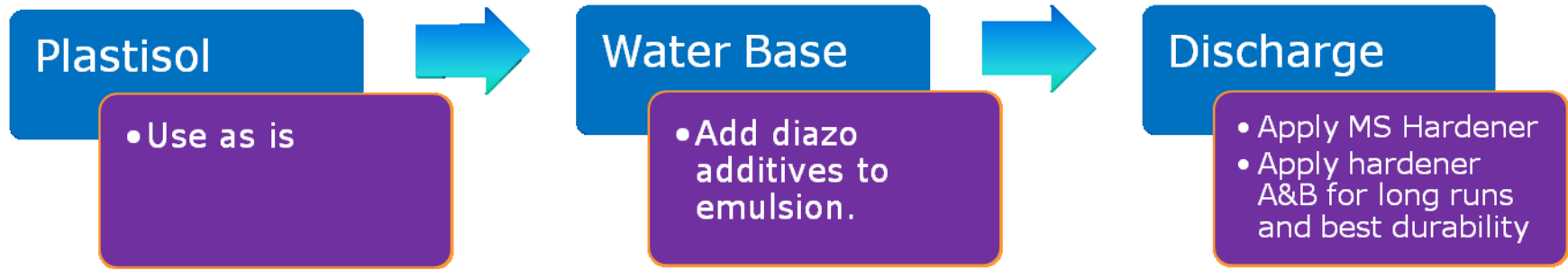


*Degrease
Screen*



*Dry
before
coating*

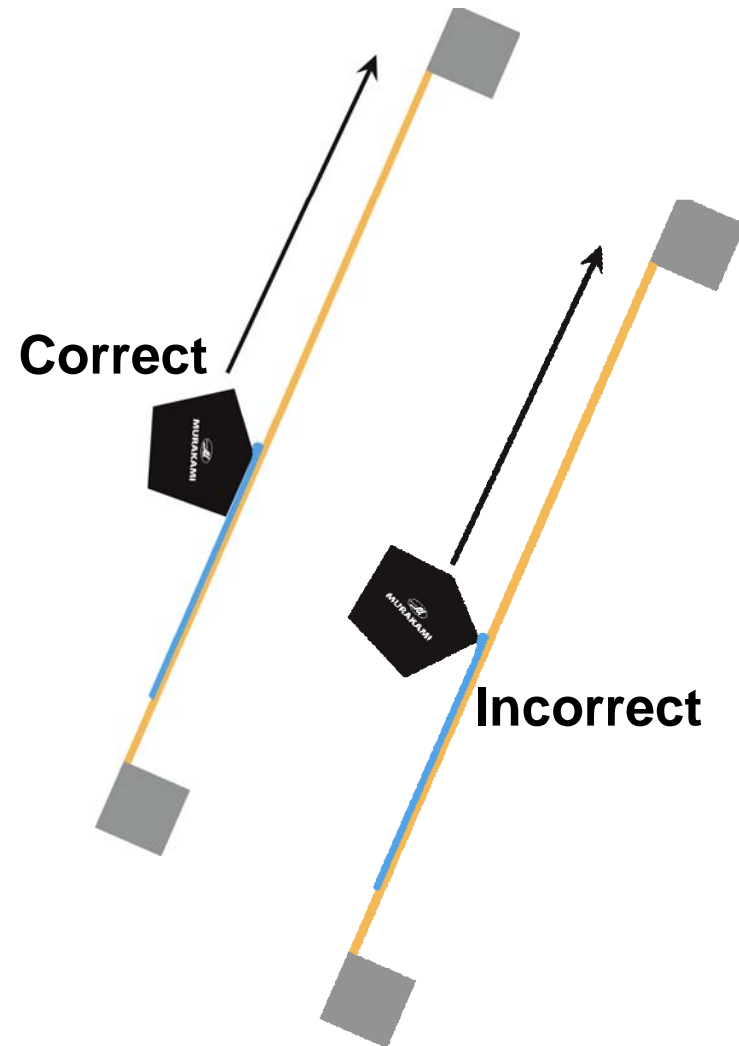
Product Application



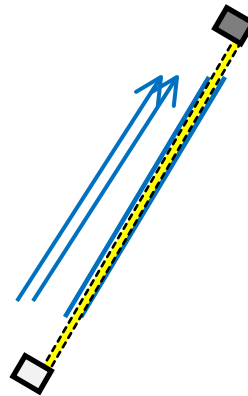
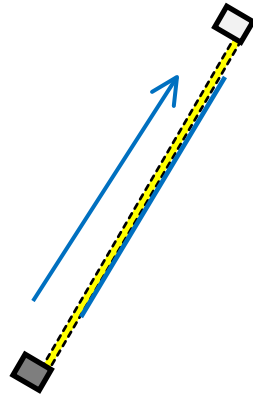
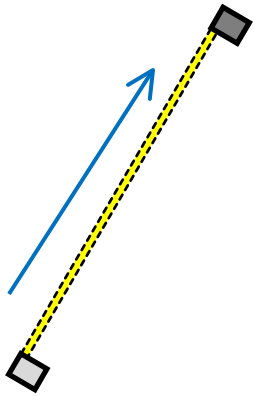
Topic 4– Emulsion Coating

Coating Techniques:

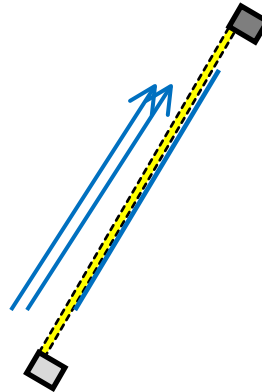
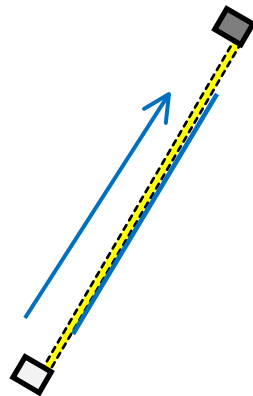
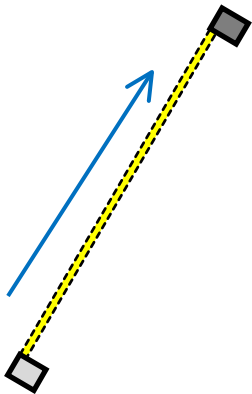
- Use **dull edge** of coater for mesh counts of 25 –200/in.
- Use **sharp edge** of coater for mesh counts of 200 – 300/in.
- Begin with one coat on print side using proper edge. Follow with one coat on squeegee side, **rotate screen frame 180 degrees** and apply second coat to squeegee side.
- **Coat slowly** using firm pressure on mesh. Coating too fast will leave air bubbles in mesh causing pinholes.
- Tilt coater over so the **end cap guide is flat** on the mesh. This improves consistency of emulsion thickness if all personnel use the flat perfect angle of the coater end cap.



Technical Tips – Coating



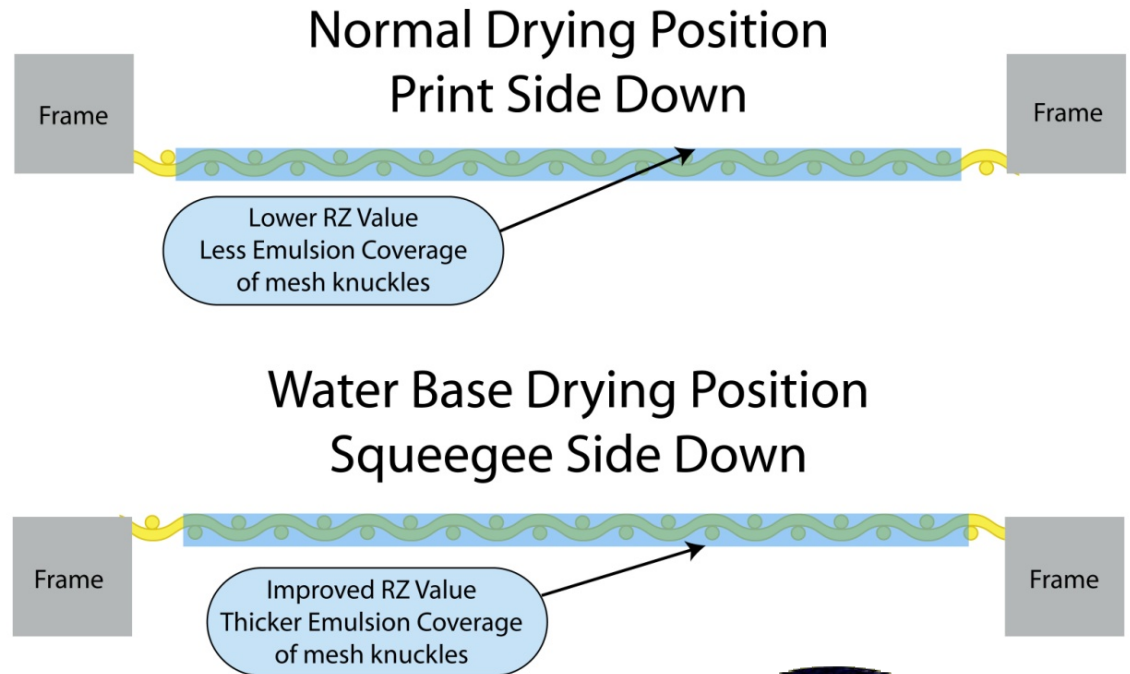
Recommended coating
Even surface profile, Right
way of building EOM on
print side – smoother and
flatter on squeegee side



Poor coating
Uneven surface profile,
Poor EOM on print side –
excessive EOM on
squeegee side

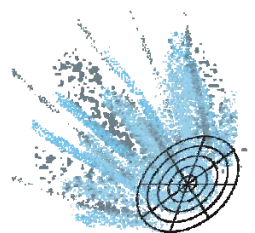
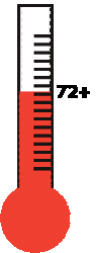
Topic 5– Drying for Waterbase Screens

- ▶ An improved RZ value on the squeegee side can help mechanical abrasion resistance.
- ▶ This can be accomplished with additional face coats, coating technique, or drying position.
- ▶ This technique works well with **High Viscosity Emulsions** like **Aquasol HV** or **Photocure PRO-HV**.
- ▶ Lower Viscosity Emulsions should be face coated on the squeegee side and dried print side down.



Screen Room Variables

- Screen room conditions can affect screen durability.
- **Humidity** should be kept to a minimum. Use of a dehumidifier is recommended. Set dehumidifier to 35%. Use two in larger rooms placing them at opposite ends of the room.
- Keep floors free of water. Avoid spray from wash out booth entering screen drying area. **Emulsion is hydrophilic**, meaning it **will** absorb water in the air like a sponge.
- Avoid drying wet reclaimed screens in the screen coating and coated screen storage areas as this will increase humidity in drying area and moisture levels in any coated screens.
- **Avoid cold** screen rooms. Keep warm at 68+ F, or use a hot box at 90-100 degrees F to thoroughly dry screens.
- Keep room free of dust and lint. A fan in an unkempt screen room will contaminate screens and create pinholes.



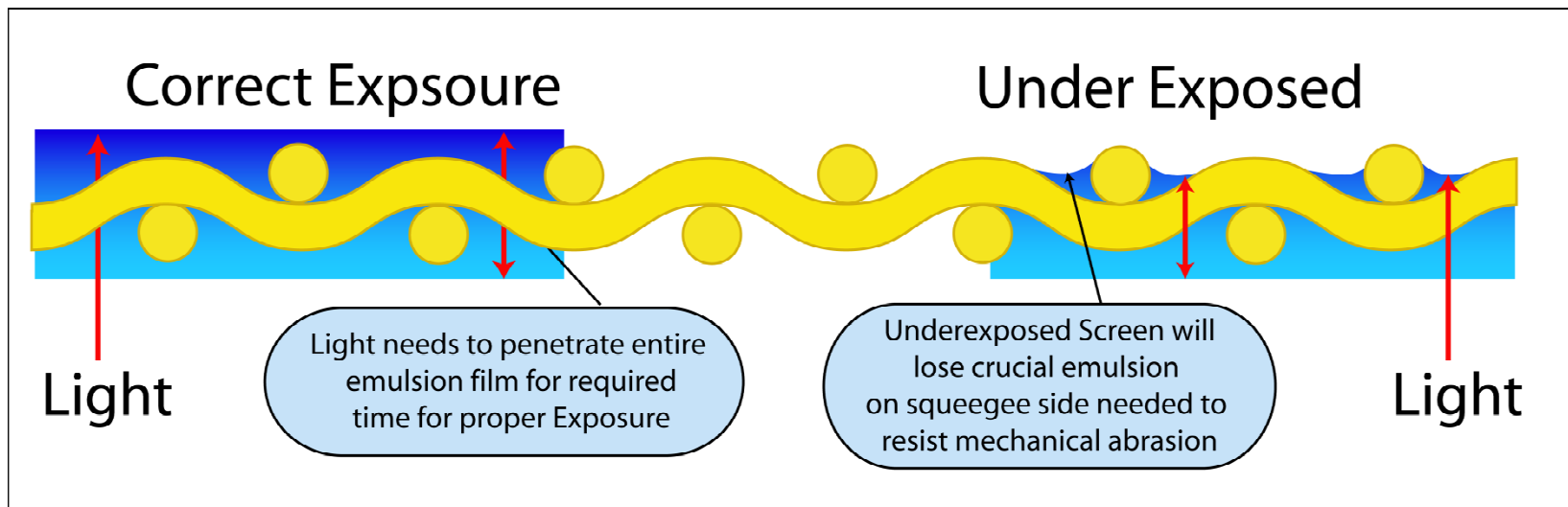
Topic 6– Emulsion Exposure

- Use clean clear positives with a D-max of 3.0 – 4.0. Keep the vacuum frame glass clean.
- Use an exposure calculator or hardness gauge to determine proper exposure time to cure the **total thickness** of emulsion.
- The spectral sensitivity of SBQ emulsion is between 360 and 420 nanometers. **Use multi spectral lamps** for improved exposures.
- Use a strong exposure lamp. **5kw** is recommended for discharge screens. Fluorescent tube light sources need additional post exposure after development to expose partially exposed emulsion.

Typical Exposure Times for SBQ pure photopolymer using a multi spectral **5KW** Metal Halide Lamp at 40”.

	Mesh	Color	Time/sec
1.	86	W	50-80
2.	110	W	35-50
3.	200	Y	30-45

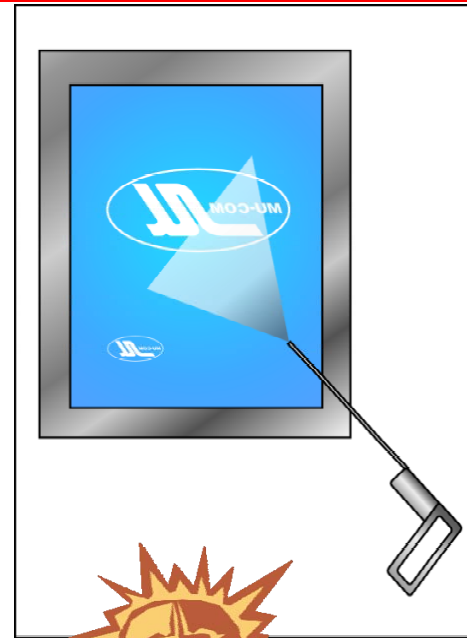
- Lower wattage lamps: Exposure times will be significantly longer and will need post exposure in sun or with exposure unit.
- Monitor bulb life and change regularly for proper light strength and multi spectral output.
- SBQ emulsions can be post exposed in the sun, diazo based emulsions lose sensitivity during development.



- ▶ Emulsions designed for waterbase work best when fully exposed. Use a pressure washer on fan spray at 12-18 inches to develop fine detail.
- ▶ Optimum durability starts with a fully exposed screen stencil. Underexposing the emulsion results in early stencil breakdown.
- ▶ Using excessive blockout on an underexposed screen will not prevent mechanical abrasion breakdown on the squeegee side.
- ▶ Check your film. If you see transparency through the black areas of the image the d-max of your film is too low and may burn through and expose emulsion.
- ▶ Murakami sells **Epson printers** with **Filmgate RIP** and **Colorgate Screenfilm** from Germany. Excellent high speed imaging with strong D-max so you can expose the emulsion completely and still get excellent details.

Topic 7– Development and Drying

- ▶ Wet stencil on both sides, wait a minute for emulsion to soften.
- ▶ Use **pressure washer** on fan spray setting at 18-24” distance.
- ▶ Continue to **wash from print side** until image is clear.
- ▶ Do a final rinse on the squeegee side to remove any residue.
- ▶ Blot with clean newsprint.
- ▶ Blow water from mesh with an air hose.
- ▶ Force dry with fan, in sun, best for post exposure, or in hot box.
- ▶ SBQ emulsion remains light sensitive after development. Post expose squeegee side to sun or lamp on long WB or discharge print runs. Allow 1 hour in sunlight, or 2-3 hours in heat.
- ▶ Drying in a hot box or in bright warm sun will help reduce moisture trapped in emulsion during developing.



Topic 8– Post Exposure

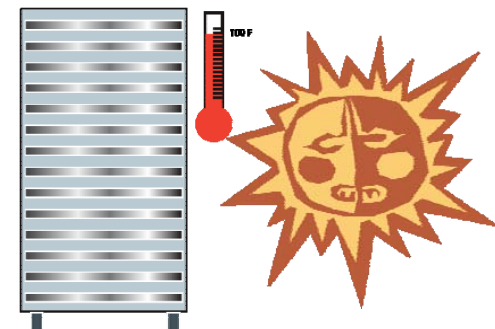
- Post exposing SBQ Emulsion continues curing any unfinished cross linking. It **should not** be used as a substitute for the proper exposure time. See 'Emulsion Exposure Tips PDF' on www.murakamiscreen.com under support on home page to determine proper exposure times. A wedge step test method is described as well as how to evaluate an exposure calculator.
- Post exposing will improve all screens to varying degrees, it significantly improves screens shot on a fluorescent light source.
- Expose squeegee side toward lamp or sun after development.
- If using an exposure lamp to post harden, wait until screen is dry and double the exposure time. Strong sun is best however.
- If using the sun, you can place the wet screen in sun, squeegee side towards sun.
- Allow screen to dry before applying Hardeners so that excess moisture doesn't dilute hardeners when applied.



Topic 9– Screen Hardening

Three degrees of Screen Hardening:

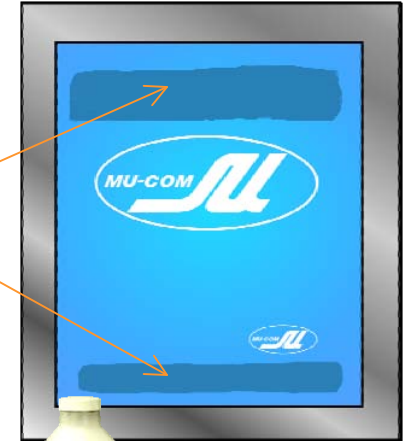
- **#1** Adding **8 grams of diazo** to Aquasol HV, Aquasol HVP, Aquasol TS, or TXR, will improve water resistance. These SBQ emulsions with diazo can provide excellent water resistance without hardeners when exposed well on multi spectral light sources.
- **#2** Add 8 grams of diazo to emulsion before coating, expose well, then use **MS Hardener** on the dry and developed screen. Apply with wet cloth to both sides, place in sun or in hot box for maximum hardening. This yields a reclaimable screen.
- **#3** Add 8 grams of diazo to the above emulsions before coating, expose well, develop and dry, then mix equal amounts of **A & B Hardener** and apply with wet rag to both sides of screen. Dry in in sun or in a hotbox for maximum hardening. This yields a semi-permanent screen. The emulsion can be broken down by applying haze remover for five minutes, then emulsion remover to break down emulsion.



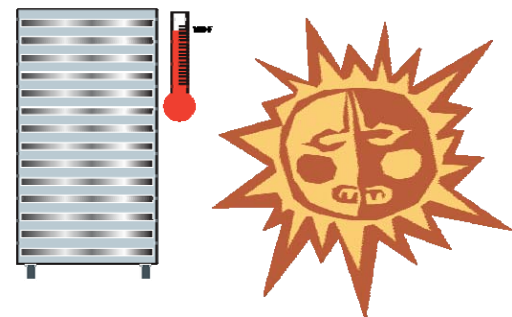
Topic 9– Screen Hardening

Reclaimable Screens:

- Once screen is dry, apply thin coats of the same emulsion around image using a sharp card or piece of plastic. Avoid thick coats and brush droplets as they will not expose completely. They will create lines or dark dots in bright discharge colors.
- For more abrasion resistance apply emulsion to squeegee side where the floodbar and squeegee start and stop.
- Required: Re-expose **dried** emulsion used for blockout in exposure unit or in sunlight. If applied to both sides, expose both sides.
- Sponge both sides of screen with **MS Hardener** or equal amounts of mixed **A&B Hardener** over entire emulsion area and dry completely in sun or a hot box before printing.



MS Hardener – A&B Hardeners



Post Hardening

- After applying liquid hardeners, dry screen well in a hot box, warm sun, top of oven if not too hot, or 2 feet in front of a force fan heater. Keep away from water sources for several hours prior to use on press.
- Screens **should not be covered with tape** over the entire bottom of the screen. If exposed properly and hardened, excess tape is not needed. Poor exposure and hardening methods along with excess tape will trap moisture accelerating breakdown.
- Pinholes should be prevented by shooting on a clean exposure unit and carding the same emulsion over non image areas. When emulsion is dry, post expose both sides with lamp source or leave in sun before applying hardeners.



Topic 10– Pre Press Check-up

When is the screen ready to print?

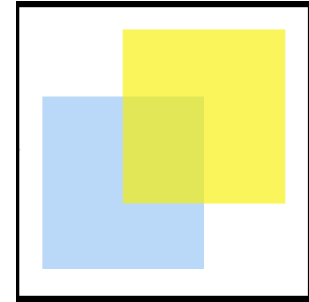
- Allow plenty of time before rushing the screen into production. Dry screens completely before exposing and after applying hardeners. Drying well ahead of production needs will yield the best emulsion performance for water base and discharge inks.
- If possible, use a hot box to thoroughly dry the screen. Putting screens into a hot box prior to production will also help remove any moisture absorbed during storage.
- Or put in warm sunlight or force dry in front of a fan to help evaporate water from emulsion. The screen may feel dry to touch but have high moisture levels within the emulsion film.
- Rushing an exposed screen to production will trap moisture inside emulsion from washout development and create a weak screen and lead to de lamination or breakdown on press.
- Use of a moisture meter (Murakami sells these) is the most accurate measurement of dryness within the the emulsion film. A screen can be dry to the touch but have too much moisture inside.



Moisture Meter

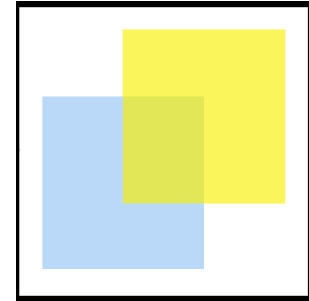
Topic 11– Printing Techniques, Water Base

- Water base ink is designed to print on white and light neutral color fabrics. Color shading will occur on colored fabrics since water base is very transparent. Ex: yellow ink over a light blue shirt.
- Try sequencing smallest print area to largest print area to avoid large print pick up areas that will soak the bottom of the next screen.
- Try placing black key lines or heavily pigmented dark inks in the first print head followed by a flash to keep sharp details. Black key lines and dark areas flash much faster than a multi-color print prior to a printed dark key line. With a highly pigmented black keyline it is possible to ‘spread’ fill colors and print over the black keyline slightly for easier register and still not see any loss of black intensity.

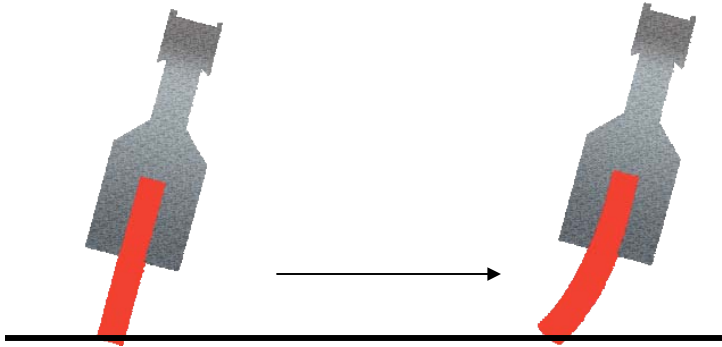


Topic 11– Printing Techniques, Water Base

- **Pure Waterbase** – designed for whites and light shirt colors.
- **Discharge** – removes shirt dye color (shirt must be dyed with reactive or direct dyes). This leaves a water base colored print when discharge is colored with water base pigments. Or use discharge ink as a base, flash, and print plastisol over the base plate. Hybrid Plastisol with Discharge additive inks do exist.
- **Dye Gain** – Printed before dyeing the shirt. Best on lights and mid tones, print will exhibit tonal gain of the dye color used to post dye shirt. Shirts must be **prepared for dyeing** and 100% cotton.
- **Dye Resist** – Print full colored prints and then dye shirt. Shirt must be dyed with reactive or direct dyes, no pigment dyes. Print retains close to original colors, some shading of inks will occur. Shirts must be **prepared for dye** and 100% cotton.
- **Super Wetting agent** –achieve interesting tie dye like effects. Print an enlarged clear base plate then print waterbase over the top wet onto wet. Agent ‘wicks’ waterbase colors out from design producing a feathered tie dye look.



Topic 12– Press set-up



Typical Plastisol
Squeegee Angle and
bend position.

Waterbase & Discharge squeegee settings:

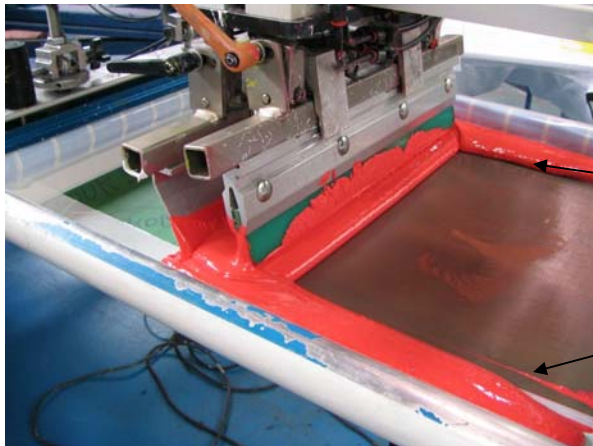
- 10-15 degrees more angle
- Minimal pressure to clean image consistently
- More angle and less pressure creates less mechanical abrasion of emulsion stencil.
- Slow down stroke speed slightly to allow ink time to penetrate fabric or use 'S' thread mesh with larger open area to improve ink transfer.



Topic 12– Press set-up



The corners of the squeegee need to be rounded and dulled for waterbase and discharge printing.



Rounded corners protect screen from breakdown. Sharp unrounded squeegee edges will promote breakdown very quickly.

Topic 13– Discharge Printing, Shirts

- Requires a 100% cotton fabric dyed with reactive dyes. You can check the fabric's ability to discharge by putting a small dot of activated ink on inside hem and run the shirt through the oven.
- Waterbase and discharge prints need to be cured with a hot air, gas fired oven at 325-350 degrees for 1½ to 2 minutes, depending on oven.
- All water must be evaporated and steamed off to achieve discharge colors. Electric ovens without forced re-circulating air do not work well.
- Try to print pre-made shirts within the same lot number for color consistency on smaller runs.
- For large runs and multiple dye lots, test one shirt from each box to make sure fabric is dischargeable and print colors remain consistent.



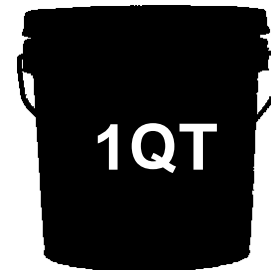
Topic 13– Discharge Printing, Shirts

- Different colored dischargeable shirts yield different discharged color. Discharge effect on different colored shirts is rated from 1-5 with 5 being the best. Check with your manufacturer about the discharge rating of the shirt color to be used. Ink color shading can occur on different colored shirts due to this effect rating.
- Even within the same colored shirts the discharge color obtained can vary during production. Communicating the uniqueness of discharge printing with your customer is recommended to avoid color complaints. Avoid jobs with tight corporate color requirements as both the shirt and the ink will cause slight color shading during a print run.
- Avoid printing on silicon washed custom dyed shirts. Silicone inhibits the ink from penetrating the fabric and can cause issues with the ink in the screen. Where possible print shirt before a silicone wash for best results.



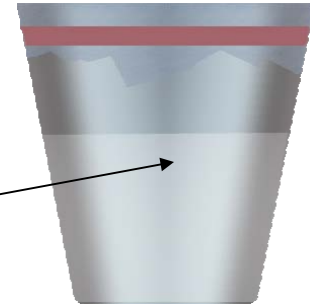
Topic 13– Handling Discharge Inks

- ▶ Keep detailed recipes of ink pigments and the exact percentage ratio by gram weight of activator for repeatable results. Use this recipe to mix “master buckets” of ink, but **never** add activator to this master color bucket. Discharge Ink has a short pot life. Always stir master ink buckets before pouring out a quart bucket to activate into a working quart.
- ▶ Activate one hour’s worth of ink for printing, about a quart+ depending on production speeds, use more for base plates. Discharge ink loses its potency over time and can color shift as components evaporate during production. Keep ink levels high in the screen adding new ink every 5 minutes or so. Stir in activator completely before using for print.

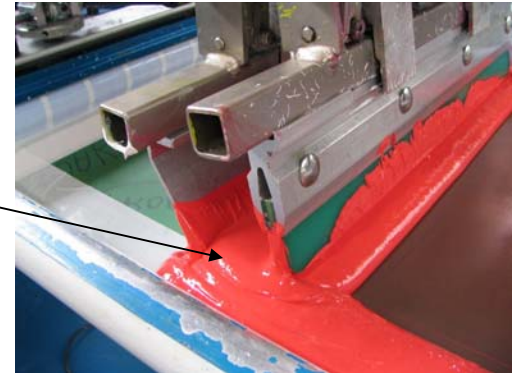


Discharge Ink Handling continued.

▶ Pre weigh activator **precisely** for one quart of ink. Use small paper/plastic cups and seal with plastic and a rubber band. Monitor ink levels in screens and activate a new quart when half a quart is still left printing in the screen.



▶ Keep ink levels in screens high. Use winged flood bars or create ink dams with tape to keep discharge ink consolidated. Push ink to center of screen often to mix with new ink



▶ Discard all inks in screens when cleaning screens for the night. Wash screens top and bottom with warm water. Use a large oscillating fan to circulate air by press to dry screens overnight.

Topic 14– Printing with Discharge Inks

- ▶ Try sequencing from **smallest print area to largest** to avoid excessive wetting on bottom of screens.
- ▶ Where possible also print **darkest to lightest** leaving white, reds and yellows in the last positions with white always in the last head.
- ▶ Keep ink levels in screens at a constant volume and **add fresh ink regularly** to keep color over the print run consistent.
- ▶ There is **no need to use a base plate** for a multi colored all discharge ink design. Print colors are more vibrant without a discharge base plate.
- ▶ You can use a flashed discharge base plate in combination with water base or plastisol for ultra soft hand plastisol prints. Note that a discharge base print is a light tan color.
- ▶ Avoid flashing if possible, unless you are using discharge just for a base. Excess heat in the shirt can cause discharge ink to start drying in screens following a flash.
- ▶ One area a flash is useful is in the next to the last head so that the puller can see the print, otherwise the first inspection won't occur until it comes out of the oven.
- ▶ A **forced air gas oven** is the best curing system. The longer the tunnel the better since belt speeds need to be slow enough to heat shirt for 1 ½ to 2 minutes. Maintain oven, change filters often, maximum airflow is needed.

Print Techniques Continued

Base

All Discharge
Print

Flash

No Flash

Sequence

Darkest to Lightest
Inks

Tips

Butt to Butt Registration,
Yellows, Oranges, Reds,
print last.

Meshes

Base: 86, 110, 110S
Fill Color: 110, 110S
Details: 160-200

Discharge Base/
Waterbase Overprints

Flash
Discharge Base
Completely

Lightest to Darkest,
or Keyline/Flash/Colors

Increase color load.
Can be overprinted for
secondary colors.

Base: 86, 110, 110S
Fill Color: 110, 160
Details: 160, 200

Discharge Base
Plastisol Overprints

Flash
Discharge Base
Completely

Standard Sequencing
for Plastisol Prints.
Flash before Keyline

May require multiple flashes
for white hi lights,
metallics, prior to keyline.

Base: 86, 110, 110S
Fill Color: 160, 200, 280
Details: 200, 280-310S



Topic 15– Printing Tips, Discharge Inks

Reducing Mechanical Abrasion

- ▶ Squeegee Selection: 65 durometer for solid areas, Triple Durometer 65/90/65 for fine lines and halftones. Murakami carries a complete line of squeegee blades needed.
- ▶ Increase angle, more than you would use for Plastisol. With a soft 65 durometer squeegee and more angle you can use minimal squeegee pressure. Slow down print stroke slightly to allow ink to penetrate garment or even better: use Smartmesh 'S' Thread from Murakami to print with faster squeegee speeds.
- ▶ Rounded blade ends produce less mechanical abrasion and wear, the most common source of stencil breakdown next to underexposing the emulsion.
- ▶ Avoid sharp, hard squeegees used for detailed Plastisol printing. When set to Plastisol printing angles, they will accelerate stencil breakdown.



Topic 16– Color Consistency Control

- ▶ Color consistency is dependent on the greige goods color of the original fabric. This is most often a neutral tan but can vary in shade over different colored shirts as not all shirts discharge completely, dischargability is rated from 1-5, check with garment manufacturer and test, test, test.
- ▶ Follow recipes exactly, pigments, base and activator all need to be in perfect balance from beginning, during and end of print run. This is crucial if you expect to print reorders as matching discharge color is harder than creating it the first time.
- ▶ Add new ink to screen regularly, activate only what you will use in an hour or two. Keep ink between squeegee and floodbar with tape dams.
- ▶ Push ink to center often to mix old and new ink, watch color and discard all ink in the screen if discharge is not occurring. Adding good discharge ink to non-discharging ink in screen will quickly cause the new ink to lose its ability to discharge.
- ▶ Document squeegee number, side, angle, speed, pressure and head number used in sampling to get repeatable color match prints.

Safety Considerations

- ▶ In the coming year a lot of mass merchant buyers will require ink to be pthalate, PVC and heavy metal free. Currently waterbase inks can achieve this at lower costs than comparable plastisols.
- ▶ Discharge Inks have zinc sufoxylate and during the curing process can emit formaldahyde and unwanted exposures to personnel. Use of an extra exhaust fan and hood at the end of the oven tunnel as well as good shop ventilation is recommended. Post washing of printed shirts with a silicone wash or just a rinse minimizes end user exposure. 'Wash before wearing' stickers also help prevent exposure to end users.
- ▶ Discharge activators should be used at minimum levels to achieve the discharge affect. Less activator equates to less potential exposure to workers.
- ▶ *Copyright Murakami Screen USA, November 17, 2008, all rights reserved.*