WATER POLLUTION ABATEMENT THROUGH RAW MATERIAL SELECTION

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On the North American Continent, effluent control is now being applied to the textile industry. As a result of this, the textile processor is now faced with acquiring a new technology, as well as additional expense in capital and possibly personnel. A review of the regulations, present and pending, in terms of BOD, COD, dissolved and suspended solids, alkalinity and possibly toxicity, defines the limits that one is allowed to work within. It does not, however, tell the processor how to achieve the required production and yet stay within these regulations.

I propose, therefore, to outline in this discussion, some of the experiences of the textile companies in the United States and to view some of the suggestions of the authorities in that country as to the nature and type of effluent discharges from various textile processing plants, in terms of the process area and in terms of the fibre being processed. The authorities in the U. S. are in active communication with the industry in an endeavour toward finding the most workable solution to the effluent problem. I also propose to outline the advantages and disadvantages of some products currently used, from the effluent control point of view.

If we examine the products currently being used in the manufacture, and process, of textiles, we find they are many and varied. *Chart One* tabulates products normally found in the desizing, keiring, bleaching, mercerizing and dyeing processes, in the most general form. *Chart Two* indicates the chemicals found in specific dyeing processes, while *Chart Three* illustrates those products associated with both printing and finishing.

To become more specific, if we list woollen processing as a group, those compounds and chemicals listed under *Chart Four* embrace most of what we find in this area.

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CHART ONE - COTTON GOODS MANUFACTURING

Desizing	- Commercial enzymes Starch (cornstarch, etc.), sizing compound Starch substitutes, sizing compounds Polyvinyl alcohol, sizing Carboxyl methyl cellulose, sizing compound Various salts Various penetrants (nonionic wetting agents) Gelatin Glues Gums Polystrene Polyacrylic acid
Bleaching/ Mercerizing/ Dyeing	- General: Chlorobenzenes Biphenyl Orthophenyl phenol Indigo Acetic acid Sulphites Benzyl alcohol Sulphuric acid Sodium busulphite Sodium dichromate Starch Glycerol Chromates Potassium bichromate Formaldehyde Muriatic acid
Keiring	- Sodium hydroxide Sodium silicate Pine oil soap Fatty alcohol sulphates Various wetting agents including miscellaneous polymers, amides, sulphates, sulphonates Methanol Ethanol Isopropanol Sodium tripoly phosphate "Calgon", softener Tetrasodium pyrophosphate Trisodium phosphate

CHART TWO - SPECIFIC DYEING CHEMICALS

Developed Dyes -
- Dye substance
- Penetrants (wetting & dispersing agents)
- Sodium chloride
- Sodium nitrate
- Hydrochloric acid
- Sulphuric acid
- Beta naphthol, developer
- Sulphated soap
- Fatty alcohol

Direct Dyes -
- Dye substance
- Sodium carbonate
- Sodium chloride
- Wetting agents
- Soluble oils
- Sodium sulphate

Naphtol Dyes -
- Dye substance
- Caustic soda
- Soluble oils
- Alcohols
- Various soaps and synthetic detergents
- Soda ash
- Sodium chloride
- Various bases
- Sodium nitrate
- Sodium nitrite
- Sodium acetate

Sulphur Dyes -
- Dye substance
- Sodium sulphide
- Sodium carbonate
- Sodium chloride

Vat Dyes -
- Dye substance
- Caustic soda
- Sodium hydro-sulphite
- Soluble oils
- Gelatine
- Perborate
- Hydrogen peroxide

Other Dyeing Chemicals
- Various thickeners
- Various hygroscopic substances
- Various dyeing assistants

CHART THREE - PRINTING/FINISHING

Melamine
Glyoxal compounds
Triazirdly phosphine oxide (APO), fire retardant
Tetrakis (hydroxymethyl) Phosphonium chloride (THPC), fire retardant.
Acrylate copolymers, soil releaser
Methacrylate copolymers, soil releaser
B-2 gum
Wheat starch
Pearl cornstarch
"Brytex" gum No. 745
KD gum
Slashing starch
Carboxymethyl cellulose
Hydroxyethyl cellulose
Tallow soap
Acetic acid
Cream softeners (cationic and nonionic)
Formaldehyde
Varicus bisulphites
Glycerin
Sodium hydrosulphite
Urea
Glucose
Gelatin
Caustic soda
Soda ash
Ammonia
Potassium carbonate
Trisodium phosphate
Sodium perborate
Sodium silicate
Liquid soda bleach
Hydrogen peroxide
Sodium chloride
Sodium dichromate
Sulphuric acid
Hydrochloric acid

CHART FOUR - WOOLLEN GOODS PROCESSING

Scouring

Chiefly detergent scouring divided as to soap - alkali process and natural detergent process

Soap - Alkali Process:

- Sodium carbonate
- Soda ash

Neutral Detergent Process:

- Nonionic detergents of the ethylene oxide condensates

Pre-Scouring and Washing

Quadratos - $Na_6P_4O_{13}$

Olive Oil

Nonionic emulsifiers for oiling

Fulling by Alkali Fulling using:

- Soaps
- Detergents
- Sod ash
- Sodium carbonate
- Sequestering agents

Fulling by Acid Fulling using:

- Sulphuric acid
- Hydrogen peroxide
- Metallic catalysts including:
  - Chromium
  - Copper
  - Cobalt
  - "Nopco 1656", soluble fatty ester
  - "Supertex E", fatty acid soaps, solvent cresylic

Dyeing

General:
- Sulphuric acid
- Acetic acid
- Ammonium sulphate
- Glaubers salt

Metallized, Wood Dyeing:
- Dye Substance
- Glaubers salt
- Ammonium acetate
- Diammonium phosphate

Bottom Chrome, Wool Dyeing:
- Dye substance
- Calsolene oil
- Sodium dichromate
- Potasium bitartrate
- Acetic acid
- Diammonium phosphate
- Ammonium acetate
- Leveling salts

Blend Dyeing:
- Surfactants
- Sodium sulphate
- Dye substance
- Various dye carriers
- Levelling agents

Other Dyeing and Printing Compounds:
- Starch
- Chrome, as $Na_2Cr_3O_7$
- Monochlorobenzene (C_6H_5Cl)
- Proteins (albumin)
- Glycerine
- Formaldehyde

Finishing
- Various carbohydrates
- Enzymes
- Dieldrin, mothproffing compound

CHART FIVE - SYNTHETIC GOODS PROCESSING

General (For all categories below)

Anti-static oils
Various lubricants
Various sizing compounds
Polyvinyl alcohol
Styrene-base resins
Polyalkylene glycols
Gelatin
Polyacrylic acid
Polyvinyl acetate

Nylon (Derived from hexamethylene diamine and adipic acid)
- Scouring:
  - Various soaps
  - Anti-static compounds
  - Fatty esters
  - Tetrasodium pyrophosphate
- Dyeing:
  - Sulphonated oils
  - Dye substances
  - Sodium nitrite
  - Hydrochloric acid

Acetates (Derived from cellulose acetate fibres)
- Bleaching:
  - Chlorine
  - Hydrogen peroxide
  - Synthetic detergents
- Scouring and Dyeing:
  - Anti-static compounds
  - Sulphonated oils
  - Various detergents
  - Various softeners
  - Aliphatic esters

(Dye types include: dispersed dyes, dispersed-developed dyes, acid dyes, and naphthol dyes)

Polyesters (In "Fortrel" polyester, derived from dimethyl terephthalate, an ester, or terephthalic acid, ethylene glycol, methyl alcohol)
- Scouring:
  - Nonionic synthetic detergents
- Dyeing and Dye Carriers:
  - Phenylphenol
  - Phenylmethyl carbinol
  - Salicylic acid

Benzoic acid
Bi-phenyl chloro-benzenes

Acrylics-Modacrylics (Derived from acrylonitrile being reacted with a comonomer in the presence of a suitable catalyst)

Scouring:
- Anti-static compounds
- Lubricants
- Sulphonated oils
- Synthetic detergents
- Various soaps
- Pine oil
- Formic acid

Dyeing:
- Various wetting agents
- Various phenolic compounds
- Copper sulphate
- Hydroxy ammonium sulphate
- Various retarding agents (cationic, anionic and nonionic)
- Aromatic amines

Bleaching:
- Chlorite
- Sodium nitrite
- Acetic acid
- Oxalic acid
- Nitric acid
- Bisulphites
- Proprietary bleaches

Rayon (Derived from 100% regenerated cellulose via viscose process)

Sizing and Desizing:
- Same compounds as used in cotton goods sizing and desizing
- gelatin

Scouring and Dyeing:
- Soluble oils
- Synthetic detergents
- Anti-static compounds
- Lubricants
- Hydrogen peroxide
- Salts
- Electrolytes

Chart Five indicates the products associated with synthetic goods processing.

Herein we have described a formidable list of organic and inorganic compounds with wide coverage of pH reactivity, possible product to product synergism and without a doubt, toxicity.

If we then look at the findings, in the United States, on the effluents from various processing plants we come up with the following characterization of the wastewaters and the suggested method of control *(Chart Six)*, all of which are approached in terms of effluent plant installation.

The U. S. authorities, with the full knowledge that the textile industry in the United States must perform its function, have drawn up suggestions for the establishment of effluent limits for discharges based on the application of the best practical control technology currently available. They collected their data by a study of various textile mills throughout the country. From this they drew up a *Schedule A,* which reflects their best technical judgments of the effluent levels which can be achieved, by the application of the highest level of control technology, now considered practical and available for the industry. The *Schedule A* values are based on the totality of experience with this technology, including demonstration projects, pilot plants and actual use, which demonstrates that it is technologically and economically reliable - *Chart Seven A*. The best available treatment should be achieved by 1983, while the best practical technology is required by July, 1977.

While the *Schedule A* would obviously apply to new plants, with existing companies, such effluent control levels could not necessarily be achieved within the given time profile. For this reason they also produced a *Schedule B* which represents the minimum acceptable effluent levels. Under their recommendations no plant should achieve less pollution reduction than the *Schedule B* values (*Chart Seven B*). The *Schedule B* is in fact a borrowed time situation as the permit permitting this condition has a limited life after which, the position at that particular mill is reviewed.

Faced with regulations such as these, textile processors in the United States have looked hard at where, by product deletion, they can meet these requirements, particularly those of low existing BOD 5, low COD and low phenolic or aromatic contents.

CHART SIX - CHARACTERIZATION OF WASTEWATERS		
TEXTILE OPERATION	WASTEWATER CHARACTERISTICS	SUGGESTED METHOD OF TREATMENT
Wool Processing Mill	Color - Brown Grease Content - High Alkalinity - High (pH 10)	Solvent extraction of grease and suint.; Screening. Dissolved air flotation. pH adjustment. Equalization. Chemical coagulation. Settling. Aerated lagoon.
Cotton-Synthetics Integrated Mill	Color - High BOD - High COD - High Alkalinity - High	Caustic recovery and reuse. Equalizing pond. pH adjustment. Bar and fine screens. Chemical coagulation and sedimentation. Carbon adsorption. Biological oxidation.
Carpet Integrated Mill	Color - High COD - High Temperature - High Latex Emulsion - High Solvent Content - High	Equalization. Fine screening. Chemical coagulation and sedimentation Carbon adsorption. Biological Oxidation

CHART SEVEN - SCHEDULE B

Recommended Effluent Guidelines - Textile Industry
(Milligrams of Pollutant Per Litre of Water Discharged)

Mill Type	Nature of Production	Gals/lb	BOD_5	COD	TSS	Alk***	Cr^t	Cr^{+6}	Phenolics	Sulphide
Wool Scour and Finish (Integrated)	Fin. Wool	35	68	206	34	205	.25	.005	.25	.5
Wool Finish......................	Fin. Wool	25	72	230	38	216	.25	.005	.25	.5
Greige Goods - Woven & Knitted Goods..........................	Greige Goods	5	72	264	72	168	.25	.005	.25	.5
Finishing - Woven Products of Cotton, Synthetics* and Blends..	Fin. Cloth	16	60	270	60	337	.25	.005	.25	.5
Finishing**-Knitted Products of Cotton, Synthetics* & Blends....	Fin. Cloth	11	54	251	65	196	.25	.005	.25	.5
Integrated Woven Goods (Includes manufacture of Greige Goods)....	Fin. Cloth	20	47	247	53	294	.25	.005	.25	.5
Carpet - Dying and Finishing, excluding secondary backing....	Pri. Backed Carpet	20	41	205	35	47	.25	.005	.25	.5
Integrated Carpet................	Pri. Backed Carpet	22	43	226	43	54	.25	.005	.25	.5
Yarn Dyeing - All Yarns..........	Yarn	18	27	133	27	54	.25	.005	.25	.5

* Principally includes nylon, rayon, acrylics, acetates, polyesters.

** May include Direct Knitting

***as $CaCo_3$

CHART SEVEN - SCHEDULE A

Recommended Effluent Guidelines - Textile Industry
(Milligrams of Pollutant Per Litre of Water Discharge)

Mill Type	Nature of Production	Gals/lb	BOD_5	COD	TSS	Alk***	Cr^t	Cr^{+5}	Phenolics	Sulphide
Wool Scour and Finish (Integrated)	Fin. Wool	35	27	103	27	58	.25	.005	.25	.5
Wool Finish......................	Fin. Wool	25	29	110	29	72	.25	.005	.25	.5
Greige Goods - Woven & Knitted Goods.........................	Greige Goods	5	36	120	48	72	.25	.005	.25	.5
Finishing - Woven Products of Cotton, Synthetics* and Blends..	Fin. Cloth	16	45	173	45	120	.25	.005	.25	.5
Finishing**-Knitted Products of Cotton, Synthetics* & Blends....	Fin. Cloth	11	44	174	54	87	.25	.005	.25	.5
Integrated Woven Goods (Includes manufacture of Greige Goods)....	Fin. Cloth	20	42	156	42	108	.25	.005	.25	.5
Carpet - Dyeing and Finishing, excluding secondary backing....	Pri. Backed Carpet	20	27	114	30	30	.25	.005	.25	.B
Integrated Carpet...............	Pri. Backed Carpet	22	33	125	33	38	.25	.005	.25	.5
Yarn Dyeing - All Yarns..........	Yarn	18	17	73	17	27	.25	.005	.25	.5

* Principally includes nylon, rayon, acrylics, acetates, polyester.

** May include Direct Knitting.

***as $CaCo_3$

From the dyer's point of view one biggest area of hazard is the carriers which are usually aromatic in nature, often toxic and certainly detectable in the wastewater effluent.

Some carriers, however, are biodegradeable. For instance, those based on Crisotinic Acid. With high temperature processing equipment, carriers are less and less in demand, and only those with good migrating properties, at temperatures of around 130°C are required on this modern equipment. Fortunately the Crisotinic Acid types have excellent leveling properties under these conditions. Unfortunately, however, Crisotinic Acid itself is in short supply in the United States, and formulated products based upon this active are quite expensive, ranging from 95¢ to $1.55 per pound.

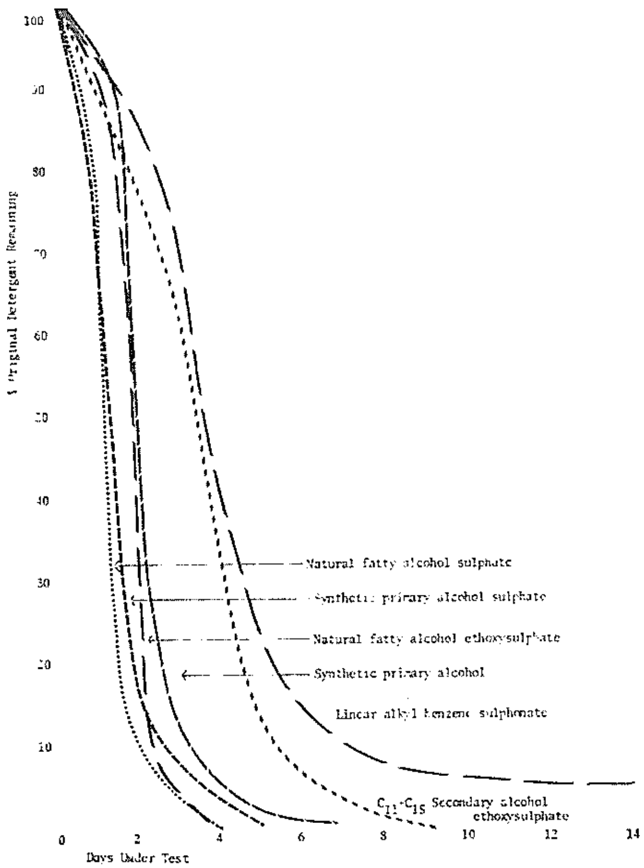
The wet processor has probably a much greater capacity to control his BOD and COD than, for instance, the weaver or the finisher.

A dyer has before him today a choice of biodegradeable preparation agents, detergents, wetting agents, dye bath auxiliaries and post dyeing softening agents than can be selected, in relation to performance, to give him exactly what he needs as regards his BOD.

Charts Eight A and *Eight B* illustrate the relative biodegradeability of a number of dye bath auziliaries, and detergents, considered generically. *Chart Eight A* shows the biodegradeability of anionic compounds, all of which appear to be satisfactory. The slowest degradeable product in this group is the Linear Alkyl Benzene Sulphonate, which is often used as the active in some lower priced dye bath leveling agents.

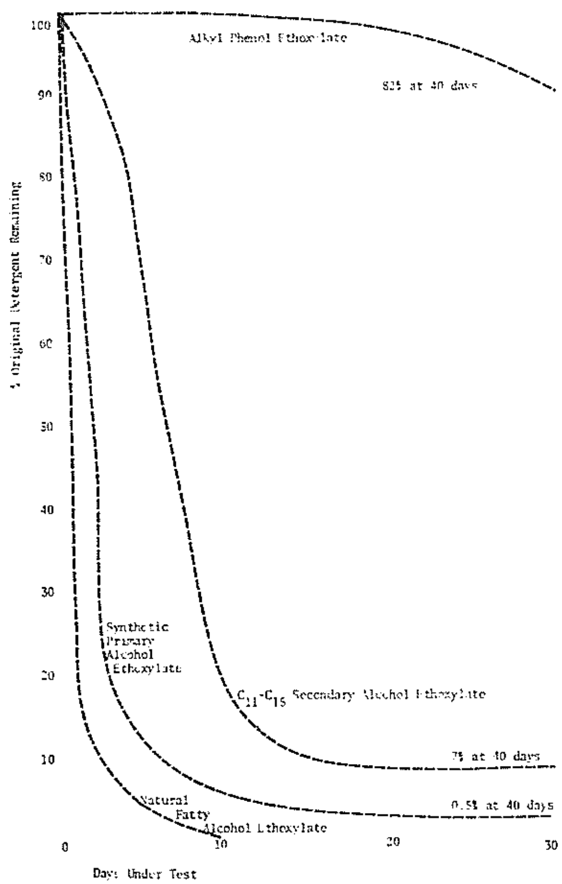
Chart Eight B shows the same method for nonionics. In this case, it is very apparent that from a biodegradeable point of view, the Alkyl Phenol Ethoxylate is a less satisfactory performer. Many textile auxiliaries are based on these compounds.

When considering the allowable BOD from your dyehouse or plant effluent, it is advisable to consult your chemical supplier for the specific BOD's of your chemicals supplied. These figures will probably be given on readings obtained from acclimated cultures. This practice is fair, because if these products are in your lagoon, those acclimated cultures will, in fact, develop and grow anyway, while the other commoner cultures will die off through lack of nutrition, unless they also find some media on which to feed. It is also suggested that you work closely with your auxiliary supplier on the question of your effluent as a whole. He should be in a position to give



Type	Product	Average % Biodegraded
Ethoxysulphates	Linear alkyl phenol ethoxysulphate	68
	Natural fatty alcohol ethoxysulphate	99
	Secondary alcohol ethoxysulphate	98
	Synthetic primary alcohol ethoxysulphate	99
Sulphates	Synthetic primary alcohol sulphate	99
	Natural fatty alcohol sulphate	99
Sulphonate	Linear alkyl benzene sulphonate	95

CHART EIGHT A
BIODEGRADABILITY OF ANIONICS BY WPRL AERATION SCREENING TEST



Product	Average % Biodegraded
Alkyl Phenol Ethoxylate	30
Synthetic Primary Alcohol Ethoxylate	97
Secondary Alcohol Ethoxylate	86
Natural Fatty Alcohol Ethoxylate	96

CHART EIGHT B

BIODEGRADABILITY OF NONANIONICS BY WPRL AERATION SCREENING TEST you first class guidance on how his product will perform from the BOD and COD point of view in your lagoon. Where a particular product with a specific end use application has an unsuitable BOD or COD, then your auxiliary supplier should formulate specifically to maintain the application requirements you have to satisfy in addition to meet your effluent needs.

A major area of problem appears to lie with some synthetic sizing compounds. Polyvinyl Alcohol, and CMC, Carboxy Methyl Cellulose, are both products that have low BOD values yet very high COD. In the United States these are causing considerable concern. From the point of view of efficiency in sizing they have, in many instances, substituted for starch and starch derivatives, which are biodegradeable, but which appear to perform over-all less satisfactorily.

The Americans have not yet resolved the problem of PVA and CMC.

The manufacturers of woollen carpets have also had to restrict certain product use. I refer in particular to the Dieldrin Moth Proofer which was the basis of many mothproofing formulations and which is now being totally withdrawn from the market, because of its high toxicity to marine life. It is my understanding that the Mitin FF product of Ciba-Geigy is one of the few remaining products that can be safely used in this area.

Trisodium Pyrophosphate, Monosodium Phosphate, TSP and other P_2O_5 donors are now used in dyehouses today as alkalis in scouring processes and for pH control in dye bath operations.

Under the first sweep by the government, the detergent manufacturers have been directed to reduce the phosphate content of household detergents to 5% as P_2O_5 by the end of 1972 and you may assume that industry will also be subjected to a close scrutiny in this area as well. Textile processes will therefore require modification so that other alkalis can be substituted and other buffering techniques evolved to reduce the consumption of phosphates.

As you saw from the A & B Schedules, chromates, and copper contamination are all areas of concern in the United States. It should be remembered that many dyestuffs contain a metal ion such as copper or chromium and these will eventually come under scrutiny as well. *Chart Nine* shows the empirical formula of some dyestuff types and from this you will see, for instance, that Direct Blue 218 has copper as has Brown 95 and Blue 86, while Acid Black 52 is a chromium donor. These are but a few of

CHART NINE

Dye Name	Empirical Formula
Disperse Dyes:	
Yellow 42	$C_{18}H_{16}O_2N_2S$
Yellow 3	$C_{15}H_{15}O_2N_3$
Yellow 54	$C_{18}H_{11}O_3N$
Blue 3	$C_{17}H_{17}O_2N_2$
Blue 7	$C_{18}H_{18}O_6N_2$
Red 60	—
Mordant Type:	
Black 11	$C_{20}H_{13}O_7N_3S$
Acid Dyes:	
Orange 7	$C_{16}H_{12}O_4N_2S$
Black 52	$C_{20}H_{11}O_7N_3SCr$
Yellow 17	$C_{16}H_{12}O_7N_4S_2Cl_2$
Orange 24	$C_{20}H_{18}O_5N_4S$
Black 1	$C_{22}H_{16}O_9N_6S_2$
Blue 113	$C_{32}H_{23}O_6N_5S_2$
Green 25	$C_{28}H_{22}O_8N_2S_2$
Blue 25	$C_{20}H_{14}O_5N_2S$
Yellow 151	—
Yellow 38	$C_{28}H_{26}O_8N_4S_3$
Black 80	$C_{36}H_{26}O_{11}N_8S_3$
Blue 45	$C_{14}H_{10}O_{10}N_2S_2$
Direct Dyes:	
Yellow 28	$C_{28}H_{20}O_6$
Blue 6	$C_{32}H_{24}O_{14}N_6S_4$
Blue 218	$C_{32}H_{20}O_{16}N_6S_4Cu_2$
Yellow 4	$C_{26}H_{20}O_8N_4S_2$
Red 81	$C_{28}H_{21}O_8N_5S_2$
Yellow 50	$C_{35}H_{28}O_{13}N_6S_4$

Red 23	$C_{35}H_{27}O_{10}N_7S_2$
Brown 95	$C_{31}H_{20}O_9N_6S\ Cu$
Black 38	$C_{34}H_{27}O_7N_9S_2$
Yellow 11	$C_7H_7O_5N\ S$
Blue 86	$C_{32}H_{16}O_6N_8S_2Cu$
Yellow 12	$C_{30}H_{28}O_8N_4S_2$
Yellow 106	—
Black 80	—
Basic Dyes:	
Brown 4	$C_{21}H_{24}N_8$
Green 4	$C_{23}H_{25}N_2Cl$
Violet 1	$C_{24}H_{28}N_3Cl$
Yellow 11	$C_{21}H_{25}O_2N_2Cl$
Blue 3	$C_{22}H_{30}O_2N_3Cl$
Vat Dyes:	
Blue 43	$C_{18}H_{14}O_2N$
Orange 1	$C_{24}H_{12}O_2Br_2$
Green 1	$C_{36}H_{20}O_4$
Yellow 2	$C_{28}H_{14}O_2N_2S_2$
Brown 3	$C_{42}H_{23}O_6N_3$
Green 3	$C_{31}H_{15}O_3N$
Blue 6	$C_{28}H_{13}O_4N_2Cl$
Sulphur Dyes:	
Black 1	$C_6H_4O_5N_2$

the selections of dyestuffs available today, and, I can foresee a need that the dyer has available to him chemical compositions of his dyestuffs so that he can again determine his best choice. The color index is very valuable for this purpose. Dyestuff discoloration in wastewater is presently the subject of much intense research and development. The American Association of Textile Chemists and Colorists are greatly concerned on this matter and a study headed by the AATCC is presently underway to address this problem.

In the United States it is considered important that measures be taken to limit or control the long-term discharge of caustic wastes and dyes, especially printing pastes. It has been suggested that additional separate disposal or reuse of excess printing pastes should be adopted. Similarly, recovery of wool grease and suint have been included in the treatment models that have been set up for wool processing. It has also been recommended that improved control over wet process operations be implemented. For instance, the use of Redox potential measurements to permit reduced excess chemical use in sizing, desizing, bleaching, dyeing, finishing, etc.

Again, in the U. S., it has been suggested that control should be exercised on water usage to reduce needs in processing and spillage as well as leaks and continuously running water hoses. Improved housekeeping is strongly underlined with the use of retaining sills, splash boards and special waste collection containers, etc.

Much attention has been given to wastes resulting from printing operations, in that excess pastes should be separated from the printing room wastewaters and the pastes collected manually, or automatically, into barrels or other suitable containers. These pastes should not be allowed entry to floor drains in the print rooms or the screen cleaning/repair rooms. The viscous printing pastes clog drain lines, sewers and treatment floor apertures and further settle out on the sides of aeration basins and in other areas where least desired. While print pastes may exhibit considerable toxicity, conversely certain pastes have extremely high BOD's from 200,000 mg/l to more than 400,000 mg/l. It has been suggested that the collected mass should be incinerated with strict caution in preventing air pollution or should be partially refined for recovery of varsol and other hydrocarbons.

For wool processing, recovery of wool grease and suint as referred to earlier, are essential in achieving the effluent limits. Recovery of wool grease by solvent systems and conversion into lanolin was practiced when the lanolin market was favorable. Today Calcium Chloride cracking or acid cracking and centrifuging are possible alternatives.

Solvent processing operations show potential for replacing wet processing in the future, in the opinion of some environmentalists. Some textile experts cite increased process efficiencies and decreased in-plant waste loads since solvent systems require little or no water. Solvent systems have been used for a number of years in wool scouring and processing. It is the opinion of some that application is now highly probable in the scouring, desizing, dyeing and finishing of all types of cotton and synthetic goods. It is claimed that solvent systems can achieve desizing, dyeing and finishing in shorter times compared to the conventional aqueous systems. Soluble natural impurities are collected at the solvent purification stills as an oily semi-solid, rather than being wasted. Highly alkaline and detergent-soap laden wastewaters, particularly from cotton scouring and desizing, may be largely eliminated and fresh water requirements reduced up to 96%. Solvent residues may be reclaimed, incinerated, etc. Some solvent systems for desizing, sizing, dyeing and finishing have been more extensively used overseas, but are relatively new in North America. Solvent recovery is thought to be presently incorporated into two or three plants in the United States. The economics of solvent systems will become increasingly favorable with a rise in wastewater treatment costs.

Outside of product selection, proper handling and disposal of spent dye baths and the associated dye rinse and washwater represents a major problem to the textile industry in terms of high levels of BOD, COD, toxic substances and intense color in these wastewaters. In-plant modifications to reduce effects of dyes and the color in resulting wastewaters may include continuous steam dyeing instead of batch dyeing; the oxidation of vat dyes by steaming in lieu of dichromate fixing; and indeed the re-use of dichromate solutions; the reclaiming of first rinses for makeup of new baths; the direct recovery and re-use of concentrated dye solutions. In dyeing synthetics or cotton-polyester blends, the Thermosol Process has been advocated for minimizing amounts of dye chemicals and waters used.

Pressure becks in place of atmospheric dyeing equipment also require less carrier material as well as permitting the choice of alternative carriers having low hazard ratings.

Other suggested routes to reduce waste in both product and water is by the use of continuous scouring in place of pressure keiring. Combined scour-desize and scour-bleach baths are also deemed desirable. Scour rinses may also be used or reused as desize rinses. Highly concentrated spent solutions of keir, mercerizing and desize liquors should be segregated from other plant wastes. These liquors may then be treated separately; more preferably these liquors can be dried and therefore re-used for keiring or mercerizing makeups, be incinerated, or undergo other appropriate disposal in the near dry state, although this method would be very expensive.

In conclusion, it would appear that as pressures mount for cleaner effluents, not to mention atmospheric emissions from your industrial plants, that the chemical suppliers, must continue to work in close accord with the processor, to meet the stringent requirements laid down for the industry.

Full illustrated text of paper delivered at CATCC, Quebec Section, symposium, January, 1973.