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EXPERT SYSTEM TO DETERMINE

THE EFFLUENT LOAD

IN THE DYEING AND FINISHING

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I. BACKGROUND & JUSTIFICATION

A. Background

-To transform grey textiles to commercial textiles, dyestuffs and chemicals are used in which large quantities of water are required.

-The effluents contain a large proportion of the chemicals and dyestuffs used to obtain the dyed and finished textiles.

By lack of technical knowledge and information an excess of chemicals and dyestuffs is often used to obtain the right shade and finishing. The result is, that a high proportion of chemicals and dyestuffs remains unfixed and will be present in the effluents.

The influence of the technical processes on the degree of fixation of the dyestuffs and chemicals is in most cases unknown.

-Most countries have problems with shortage of water and high degree of pollution of the textile effluents.

The available information is often not sufficient to indicate to the dyer and finisher which is the optimum quantity of rinsing and washing water to be used.

-If purification installations are available they are often not sufficient to eliminate all the dyes and chemicals present in the effluents.

The large variety of processes and chemicals in the textile dyeing and finishing industry and the large fluctuations of effluent quantity complicate the optimum utilization of a purification unit.

-The cost and purification of the water represent an increasing proportion of the transformation costs.

B. Justification

The project will permit analysis BEFORE transforming the textile.

The previsional pollution load and cost of a production lot will be calculated.

Different alternatives will be presented in order to select the transformation method producing the least effluents.
Both the quantity and the pollution load of the effluents will be reduced.

All the dyehouses and finishings are involved.

When a textile industrial project has to be analyzed, the project will incorporate information about pollution load of the effluents and the related costs.

II. THE PROJECT

A. Project Objectives

- To develop a software package which will assist textile dyers to determine the production pollution load.

- This program will permit the study of different alternatives (influence of the process, of the recipe, influence of the lot size,...) and indicate the alternative allowing the selection of the production method producing the least effluent loads.

- This program must also help the production dyehouse manager to become aware of the higher pollution degree when he/she is dyeing some special shades, and/or dyeing special qualities requiring more preparation or a special finishing, and/or using the wrong equipment for the lot size, ...

B. Outputs

-The project consists mainly in the development of a computer program. In this program the ecological data of dyestuffs and chemicals will be analyzed and introduced.

-Technical information important to ecological studies will be introduced as processes, machine types, quality groups,...

-Different simulations will be performed.

-The program will then be finally adapted in order to achieve the objectives and fulfill the requirements.

-The program will then be available as a pollution control module.

Requirements and structure of the program :

1.REQUIREMENTS

This system will be widely distributed by Unido. To be able to do this without problem the system must be able to work on as many as possible existing computer systems.
The hardware and software prerequirement must be as low as possible to reduce the cost of installation. The following prerequirements have to be therefore formulated:

- The system must work as a stand alone.
  The use of a spreadsheet program is not possible as the cost of the spreadsheet must be counted for each system installed. The system must be developped with a environment without an expensive licence fee. A licence fee paid once for an unlimited amount of installation is the best solution.

- The operating system must be MS-Dos
  MS-Dos is the most widely available operating system on personal computers. Now MS-Window is becoming widely available but not every personal computer has Window installed. Window can not be installed on every PC without hardware and software upgrades. To be able to work on as many existing systems (without supplementary costs) the system must be able to work on MS-Dos.

- The module must be easy to install.
  The software will be installed in a wide variety of production units. The production technicians have in most cases no special computer knowledge.The program must be easy to load from a diskette.

- The program must include a tutorial program.
  Production technicians, if no computer addicts, will seldom read or even consult a manual explaining the program. When the program is running a help function must be foreseen. The user will be able without quitting the program to obtain an answer to his specific questions.

- The demands must be formulated clearly in order to guide the user to give the required information for the calculation of the ecological data and pollution load.

- The software must be developped such that when the recipe is not recommended, an alternative recipe can be found with feed-back which reduces and avoids undesirable pollution agents.

- The module must already contain selected ecological data of the major dyestuffs and chemicals. (COD, BOD, metal, halogen, % biological elimination)

- The additional information, if introduced by the user, must be filed separately and identified, to be checked later on, if needed.

Important fibers, processes, machine groups, dyestuffs and chemicals must be introduced in advance. The program will be widely distributed in a large variety of textile production units and countries. All the missing data will be introduced in the production unit. These data are not allways reliable und must be easily identified by the Unido specialists. These data have to be checked and corrected if needed.

- The calculated effluent loads must be in accordance with local legislation. If no water purification facility is availabie, the recipe will be rejected if a calculated value exceeds the permitted value.

- The reason of rejection must be given.

It must be clearly stated which chemical or which chemical quantity causes the rejection.

- The simulation program must be used for different lot sizes, dependent on preparation, dyeing or finishing.

The preparation, dyeing or finishing will in many cases be performed on different machines. In those cases the lot size for the dyeing will be different than for the preparation and finishing. The number of preparations and finishings is lower than the number of shades.When different dyeings will be studied the lot size of each dyeing is an essential parameter to calculate the pollution load of the effluents. The dyeings can then be regrouped in larger lots to calculate the pollution loads for the preparation and finishing.

- The effluent load after purification must be calculated, if this facility is available.

It is important to calculate this value in order to be able to calculate the total water and purification cost.

- The standard cost of treating the effluent and water recuperation must be calculated.

These costs will help the user to decide if an improved water recuperation must be installed and generally which investments are feasible to improve the water treatment.

2. STRUCTURE

The pollution control module will be structured as follows:

- A) In a dyestuffs and chemical file the major ecological parameters will be introduced. The parameters will be introduced as a simple value: this value should have the possibility to be modified.

- B) A simplified preparation, dyeing and finishing process file, in which the fixation degree of the chemicals and dyestuffs will be taken into account.

- C) A machine file containing the global technical features of the majority of the production units. (such as machine type)

- D) A quality file in which the major features will be introduced. (as type of fiber, type of size,...)

The files will contain standard preparation, dyeing ,finishing methods, standard qualities and standard machines .This basic information along with the ecological values and the fixation degree of dyestuffs and chemicals will be prepared and introduced in the ecological test program.

3. ECOLOGICAL PRODUCTION CONTROL :

ECOLOGICAL CONTROL OF A RECIPE FOR A GIVEN PRODUCTION LOT

The user of the program will have the abality to select the most suitable preparation, dyeing ,finishing methods, quality and machine group.

In order to avoid the creation of a new item each time, the list presented must be sufficiently complete to help the user in most cases.

After having selected the methods, quality and machine group, the user will introduce the volume of the machine and the quantity to be dyed.

From a dyestuff and chemical list the user will select the dyes and chemicals to be used in the recipe and enter the quantity (in %, g/l. or directly in grams).

The program will calculate the effluent load of the production lot.
The fixation degree dependent on the process will be automatically taken into account.
If the dyestuff is not present in the list , the user will be able to select a dyestuff with a similar color-index or by default a dyestuff from the same family (for this "general" dyestuff, global ecological figures will be introduced)

The same methodology can be used for the chemicals: if the desired chemical is not present in the list, the user should have the ability to select a chemical of the same group (A group of chemicals regroups chemicals having a similar end-use in the textile industry and similar chemical structure: example the group of softening agents based on silicones)

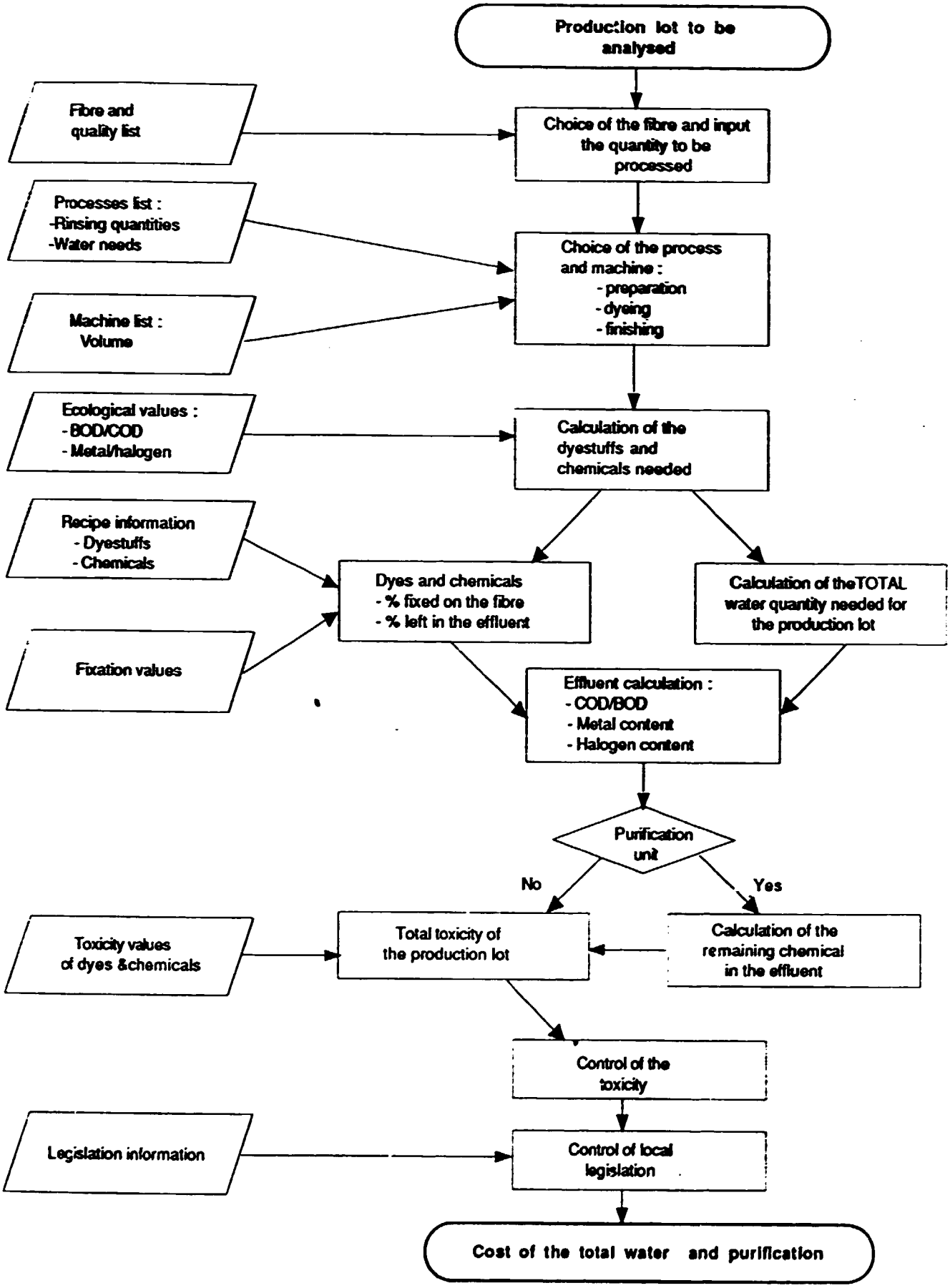
Average ecological values can be used for the group. This approach will permit a rough calculation of the pollution load of the recipe even if all the exact values are not available for all the recipe chemicals.

The quantities of dyestuffs and chemicals being rejected in the effluent will be calculated for every production lot.

For the preparation and the finishing this quantity will be different if different production lots are regrouped.

When these quantities are calculated and if the the ecological values are available, the effluent load will be calculated before purification of the effluent.

4. FLOW CHART


Production lot to be analysed
Fibre and quality list
Choice of the fibre and input the quantity to be processed
Processes list : -Rinsing quantities -Water needs
Choice of the process and machine : - preparation - dyeing - finishing
Machine list : Volume
Ecological values : - BOD/COD - Metal/halogen
Calculation of the dyestuffs and chemicals needed
Recipe information - Dyestuffs - Chemicals
Dyes and chemicals - % fixed on the fibre - % left in the effluent
Calculation of theTOTAL water quantity needed for the production lot
Fixation values
Effluent calculation : - COD/BOD - Metal content - Halogen content
Purification unit
No
Yes
Toxicity values of dyes &chemicals
Total toxicity of the production lot
Calculation of the remaining chemical in the effluent
Control of the toxicity
Legislation information
Control of local legislation
Cost of the total water and purification

C. ACTIVITIES

1.Development of the computer program

A selected database will be used.
The relational database will contain different files:

- Fibers and qualities
- Processes
- Dyestuffs
- Chemicals
- Machines
- Legislation

Procedures will be programmed in the database in order to develop the desired structure.
The differents steps of the program will be programmed as displayed in the flow-chart. Lists will be available when input of data are needed.
When a recipe has to be tested, the program will ask to select the desired item (Fiber, processes, machines, dyestuffs and chemicals) and to introduce a quantity (for the dyestuffs and chemicals)
The results will be displayed and printed.

The program must be intensively tested and debugged.

2.Collection and study of the data needed to be introduced in the ecological control module

The ecological values of the dyestuffs and chemicals suppliers will be analyzed and verified.
The test methods used to evaluate the ecological data must be checked before to select the essential criteria.
Not only general information will be requested from the suppliers but also detailed information about the exact test conditions.
Information about the chemical structure of the component will help the verification of the obtained ecological values.

3.Study of the criteria

- If a water purification unit is available, the degradation criteria
  - biological elimination in %
  - ratio COD/BOD

  will be taken into account before checking other criteria such as fish toxicity, mammal toxicity.

- Criteria such as metals and halogen must be considered independently.

- Mean values of the different ecological parameters will be prepared to represent the ecological identity of the chemical group.

- The fixation degree of the chemical or dyestuff for each main process will be either checked, if available, or otherwise evaluated.
  This fixation degree is more difficult to obtain from the suppliers than the ecological values because this fixation degree is dependent on the process, the type of machine, the fiber , the pH of the water,..
  This essential part of the study will require not only technician work in a laboratory but also a critical study of available data.
  Much knowledge and experience will be required to prepare a fixation data file suitable to the operating conditions in the production of textiles.

- Study of the quantity of water te be used:
  In the textile litterature a lot of information is available about the optimum quantity water to be used. This quantity of water is dependent on the process, fiber type, quantity of dyestuffs and chemicals,machine type,....
  Realistic values must be selected.

A laboratory will also be used:

- to check and evaluate fixation values (by making small scale dyeings)

- to control uncertain ecological values

- to complete missing ecological values

- to study specific chemicals and dyestuffs by request of some users

4. Work program	A	B	C
1. Development of a base module - selection of the database - testing the module with some available ecological and fixation values - selection of the ecological criteria	2	12	6
2. Collection and control of the ecological values obtained from the suppliers of dyestuffs and chemicals 500 dyestuffs 1000 chemicals	2	-	20
3. Study of the preparation, dyeing and finishing processes and adaptation of the ecological values to the process and machine conditions (degree of fixation, relative importance of the ecological parameters,water consumption,...)	5	-	20
4. Adaptation of the base software module to specific requirements (degree of fixation, as variable, calculation of cost of water recuperation, introduction of global ecological values)	3	5	5
5. Test installation and debugging of the software, adaptation of the software to existing legislation, environmental constraints (as shortage of water, unavailability of some chemicals, ...)	3	4	10
6. Final adaptation of the software module	1	4	-
7. Further collection and control of ecological values and introduction in the module 1000 dyestuffs - 1000 chemicals	1	-	20
Weeks	17	25	82
Month	4	6	17

A : Management and coordination work
B : Software development
C : Textile analyst work (This part will be subcontracted to Cetiqt)

5. Job description

A: Management and coordination

- Follow-up of the software development

- Collect all the standard preparation, dyeing and finishing processes

- Selection of the processes, machines and fibers

- Calculation of the process specific water requirements

- Follow-up on the study of the ecological and fixation values

- Coordination work

B: Software developper

- Development of a program structure suitable to fulfill the requirements and adapted to the flow-chart

- Development of a program completely guiding the user with explanation facilities

- Adaptation of the program to introduce the different preparation, dyeing and finishing methods

- Contacts with the textile analyst to improve the performance of the program and helping to introduce the key values

C: Textile analyst

Principal tasks will be :

- Collecting the ecological values from the dyestuffs and chemicals suppliers

- Checking and selecting the needed values

- Organizing laboratory tests to control some existing values and evaluating the missing ecological values

- Executing dyeings to evaluate the fixation degree of dyes and chemicals

- Introduction of the ecological and fixation values in the developped computer program

- Testing the program

- Introduction of the program in selected production units

- Study of local legislation