AN INTEGRATED KNOWLEDGE-BASED DECISION SUPPORT SYSTEM FOR AN ACTIVATED SLUDGE WASTEWATER TREATMENT PLANT

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ABSTRACT

The activated sludge process is commonly used for secondary wastewater treatment all around the world. This process is capable of achieving high performance results. However it has the reputation of being difficult to operate because of its poorly understood biological behavior mechanisms and information that is based on qualitative data. It was long recognized that the operators of activated sludge plants should be equipped with convenient and efficient methods that augment this incomplete knowledge with experience and as a result knowledge-based systems were introduced to the field. This paper summarizes the development stages and components of the Activated Sludge Expert system (ASExpert), which is a prototype for an integrated knowledge-based decision support system dedicated for the operators of conventional activated sludge plants. It is made up of a rule-based expert system plus a complete database tool. This paper focuses on the expert system module to explore the new technique implemented for its development. Finally the paper concludes that expert systems technology proved its importance for enhancing activated sludge plants' performance. In Egypt- where enormous investments have lately been dedicated for the construction of these plants- using applications like the ASExpert system could certainly increase the anticipated pay-off and can be considered as important training tools as well.

Keywords: Activated sludge, Expert systems, Knowledge-based systems, Decision support systems

INTRODUCTION

Wastewater is a combination of water-carried wastes produced from domestic, storm water, commercial and industrial sources. It has a very complex composition, containing many forms of polluting matter, dissolved impurities and a heterogeneous dispersion of organic and inorganic solids, both colloidal and suspended. It should be effectively treated or many problems would arise.

The Activated Sludge process is nowadays the most used biological process for domestic wastewater treatment. Figure 1 depicts the main units of a typical activated sludge plant, which is basically composed of an aeration basin and a clarifier in series. In the aerator, the influent organic material is metabolized by microorganisms present in the sludge flocs where mechanical or diffused aeration provides the required oxygen and keeps the sludge flocs in suspension. Then when the mixed liquor enters the clarifier, liquid-solid separation occurs due to gravity settling of flocs. From here, most of the activated sludge is recycled back into the aeration tank -to maintain a certain food to microorganisms ratio-and the excess is disposed of [1, 2].

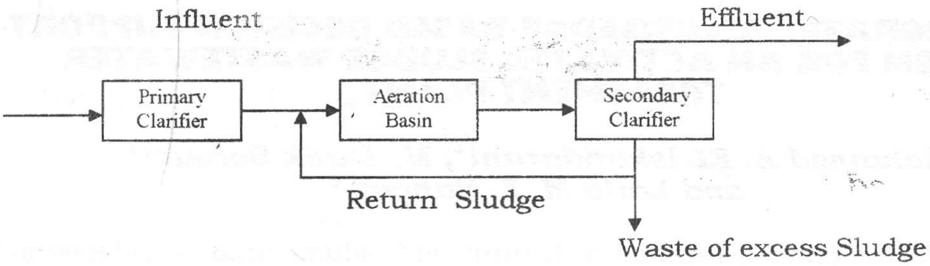


Figure 1 The main units of a typical activated sludge plant.

The main objective of activated sludge plants is to transform raw sewage into an effluent that meets standards defined by environmental drainage authorities. Although the activated sludge process is of widespread use, in practice its operation is still carried out with unqualified manual operation. Usually traditional control strategies are just applied to achieve a prefixed level of water quality at the outlet and under normal conditions (conditions closest to the design) the plants work well [3, 4]. However complete control of the activated sludge process is not yet solved because of the complexity and number of factors involved, the strongly nonlinear characteristics of the process, lack of sensors for on-line measurement and current mathematical models that still cannot accurately describe process dynamics. As a result the control methodologies alone are not enough to handle process upsets when uncontrollable situations arise but management based on operators' experience becomes essential [4, 5]. Also much of the information used is based on data that is inexact, uncertain and qualitative (important factors such as observations related to color or odor for example can only be described qualitatively). Thus to overcome this difficulty knowledge-based systems (KBS) or expert systems were introduced to the field. The available literature on this subject reflects that there are a number of ways for building these systems to be used for the design, evaluation, diagnosis, operation and control of the activated sludge process etc. [3-7].

Knowledge-based expert systems, or simply expert systems, use human knowledge to solve problems that normally would require human intelligence. These expert systems represent the expertise knowledge as data or rules within the computer. These rules and data can be called upon when needed to solve problems. Conventional computer programs perform tasks using conventional decision-making logic containing little knowledge other than the basic algorithm for solving that specific problem and the necessary boundary conditions. This knowledge is often embedded as part of the programming code, so that as the knowledge changes, the program has to be changed and then rebuilt. Knowledge-based systems collect the small fragments of human know-how into a knowledge-base which is used to reason through a problem, using the knowledge that is appropriate. A different problem, within the domain of the knowledge-base, can be solved using the same program without reprogramming. The ability of these systems to explain the reasoning process through back-traces and to handle levels of confidence and uncertainty provides an additional feature that conventional programming doesn't handle [8].

Most expert systems are developed via specialized software tools called shells. These shells come equipped with an **inference mechanism** (*backward chaining, forward chaining, or both*), and require knowledge to be entered according to a specified format. They typically come with a number of other features, such as tools for writing hypertext, for constructing friendly user interfaces, for manipulating objects, and for interfacing with external programs and databases. These shells qualify as languages, although certainly with a narrower range of application than most programming languages [8].

This paper summarizes the exerted effort to adapt and develop the Activated Sludge Expert (ASExpert) system. The ASExpert system is a prototype for an integrated knowledge-based decision support system. It is designed to act as a decision aid tool for operators of conventional activated sludge plants to help them better diagnose operating conditions and as a result select appropriate control actions. It has a very user-friendly interface and does not require special programming skills to encourage ordinary operators to use it and to allow using it as a training tool for the new ones. In Egypt, it can provide an additional support as the use of activated sludge plants is still new and naturally not much operational control experience has developed yet.

The system is made up of a rule-based expert system module plus a complete database tool for data recording and retrieval. Its knowledge base is made up of 169 rules that correspond with the working conditions of the Halton Southwest water pollution control plant in Canada [9, 10]. The paper will only focus on the expert system component of the ASExpert system to explore the new technique implemented for its development.

This paper is organized as follows: the first section describes the main components of the system and the procedure followed for its development. The second section concentrates on briefly demonstrating its features and capabilities using mainly print-outs of the system's screens during a consultation session. Finally the paper ends with the conclusion reached and suggestions for future work.

THE ASExpert SYSTEM

System Architecture

The ASExpert system is made up of the following components (Figure 2):

- Expert system tool.
- Database tool (data entry sub-system, data graph tool & a report generator).
- User-interface through which the user interacts with both tools.
- On-line help component.

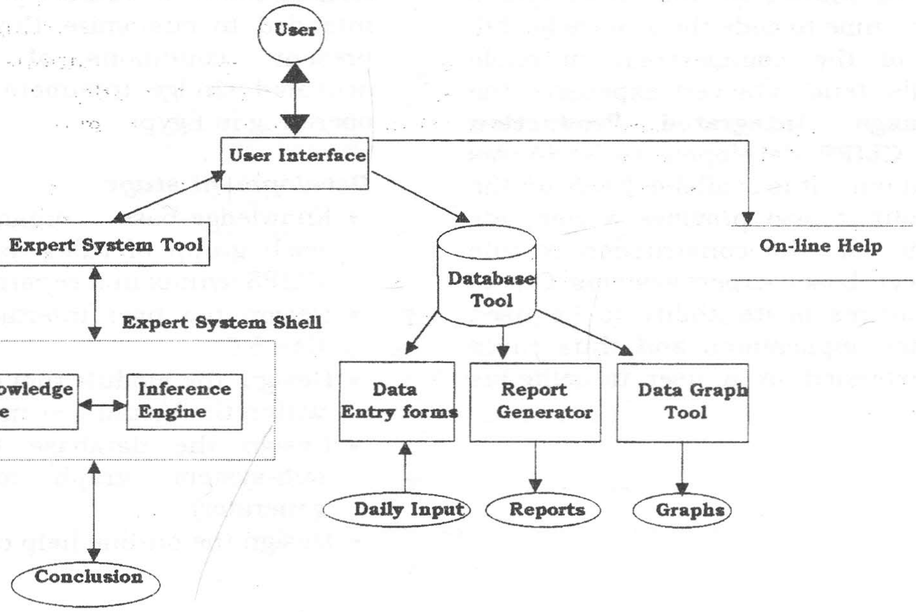


Figure 2 Block diagram of the ASExpert system components [11].

Development of the ASExpert System

The following steps describe briefly the system's development stages: (see Figure 3).

Pre-development stage

- Collect literature on the use of expert systems technology for the operational control of the activated sludge process.
- Study the possibilities for knowledge acquisition.

Select the convenient software that could handle the current requirements and could also be maintained to satisfy future needs. Lisp, Prolog, C, C++, Smalltalk and others are all good programming languages for writing expert systems. However expert system shells are nowadays established as the most suitable prototyping tools. An expert system shell is essentially an expert system without any knowledge. The basis for shells is that one does not have to write the **inference engine** (the routing mechanism that processes the rules or other type of knowledge and expertise based on the facts of the current situation) nor the user interface for each new expert system. One should only focus on the collection and verification of knowledge and thus requires a minimum time to code the knowledge [9]. As many of the commercially available expert shells tend to be very expensive, the **"C Language Integrated Production Language" CLIPS** developed by NASA was chosen. Not only, it is available freely on the Internet, but it also provides a complete environment for the construction of rule and/or object based expert systems. One of its key features is its ability to be used within other applications and thus could easily be extended by a user to suite his needs [12].

Knowledge acquisition stage

After an intensive review of the technical literature on the subject it was found that:

1. Reported expert systems in the technical literature for wastewater treatment mostly use rules that are site-specific i.e. not easily transferable to other plants.
2. The literature seldom provides a full documentation of these rules.
3. The necessary knowledge acquisition needed to develop such a system would require a lot of time and would necessitate the assistance of expert and skillful operators.
4. The use of activated sludge plants in Egypt is still considered new and not much experience regarding plant operation is developed yet.

Thus the knowledge-base component of the system was acquired through correspondence with Prof. G. G. Patry who is one of the pioneers in applying AI techniques to the field and who co-developed one of the principal activated sludge expert systems cited in literature [9, 10]. Most of these rules are readily transferable to other plants and it is intended to customize the system to fit the present conditions of a conventional activated sludge treatment plant currently operating in Egypt.

Development stage

- Knowledge-base organization: where each group of rules is coded using the CLIPS syntax in a separate file.
- Design the user interface using Visual C++ 5.0.
- Design the module that calls CLIPS from within the Visual C++ interface.
- Design the database tool (data entry sub-system, graph tool and report generator).
- Design the on-line help component.

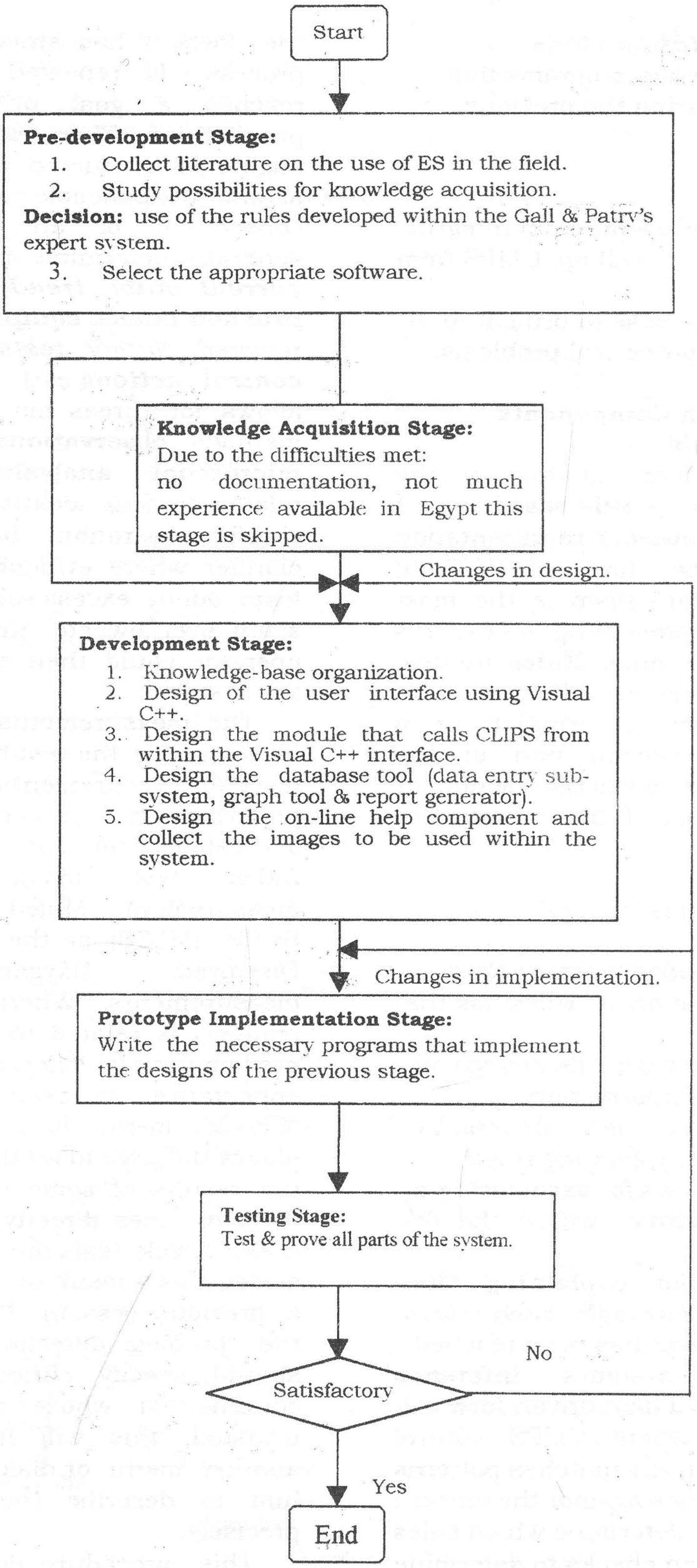


Figure 3 A flow chart of the development stages of the ASExpert system..

Prototype implementation stage

Write all the necessary programs that were fully designed during the previous stage.

Testing stage

- Test the user-interface program integrity and the flexibility of calling CLIPS from within it.
- Test the knowledge base to bring it to its final form using hypothetical problems.

The ASExpert System Components

Expert system module

The expert system module of the ASExpert system is a **rule-based** expert system where the knowledge representation formalism takes the form of (If-Then) associations. This formalism is the most popular means of representing the expert's knowledge about his domain. **Rules** are two-part conditional statements the first or the antecedent expresses a situation or a premise while the second part or the consequent states a particular action or conclusion that applies if the situation or premise is true.

IF MLSS concentration is *low and decreasing*
THEN *decrease* the Sludge Wastage Rate

Knowledge representation as rules has the following advantages:

1. **Modularity** where each rule defines an independent piece of information.
2. **Incrementability** i.e. new rules can be added without affecting existing rules
3. This formalism allows for **associating a degree of uncertainty** within the (If-Then) statements.
4. It also allows for **explaining the reasoning process through back** traces i.e. how this conclusion has been reached.

The ASExpert system's **inference mechanism** employs a data driven **forward-chaining** strategy where CLIPS control mechanism automatically matches patterns of the rules IF clauses against the current state of the fact list to determine which rules are applicable. It then checks to determine what additional rules might be true, given the facts it has already established. This process is repeated until the program reaches a goal or runs out of new possibilities. Then when CLIPS inference engine is instructed to begin execution the actions of applicable rules are executed. The consequent of an applicable rule will generally determine in our case the plant's ***current state***, ***trend*** *of plant state change,* ***problem cause***, ***equipment*** *to be checked or repaired, further* ***tests*** *to undergo, corrective* ***control actions*** *etc.*). The ASExpert system allows for threes major problem detection methods; **observations**, **measurements** and **microscope analysis**. Observations are related to four locations; influent, primary clarifier, aeration basin and secondary clarifier where evidence of unusual colour, foam, odour, excess solids, floating sludge or scum overflow etc. that are detected by the operator could then be investigated using the system.

The measurements selection allows for investigating the results of four of the main tests or measurements that are periodically performed in any activated sludge plant; settleability test or the Sludge Volume Index test (SVI), sludge blanket measurement, Mixed Liquor Suspended Solids (MLSS) or the centrifuge test and Dissolved Oxygen (DO) level measurements. Whereas the microscope analysis is related to the investigation of predominating microorganisms and floc appearance as seen in Figure 4. The "Check" menu is a separate menu that allows the user to let the system investigate the results of some the additional check tests whether directly (routine tests) or if these check tests are recommended by the system as a result of the user input during a previous session. Thus after specifying the problem detection method, the user should specify either the location or a certain test whose results seem to be unusual, this will further take him to another menu or dialog box that will guide him to describe the present condition precisely.

This procedure determines the search path to be followed by the ASExpert system.

Also this structure using simple questions trims the number of rules to be loaded into the memory and thus reduces the search path for the inference engine and enhances the system's speed performance. (The thick line in Figure 5 determines the search path where observations related to unusual foam in the aeration basin is the case).

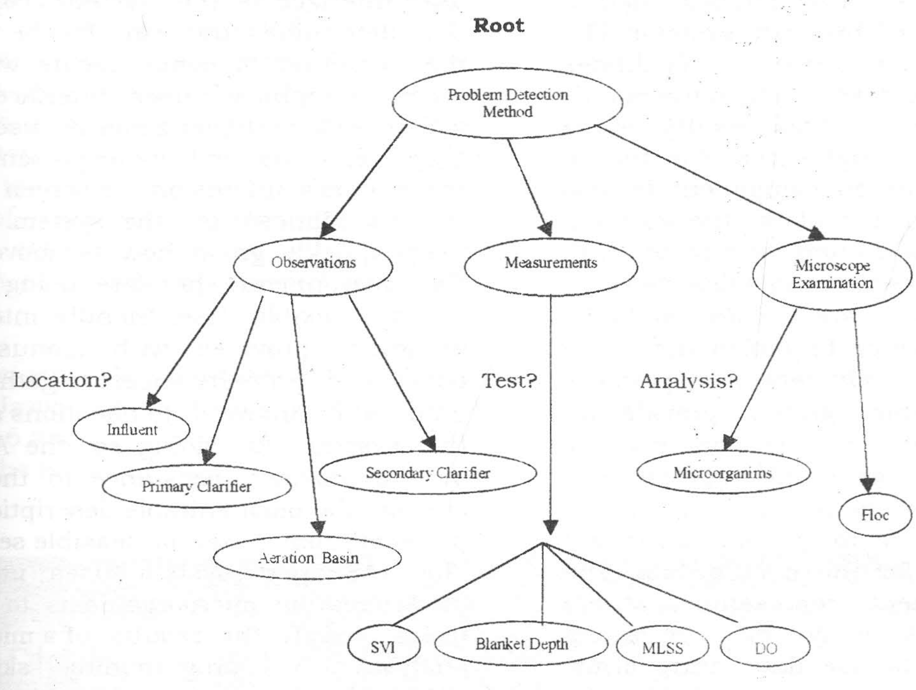


Figure 4 Schematic of the rules logic tree.

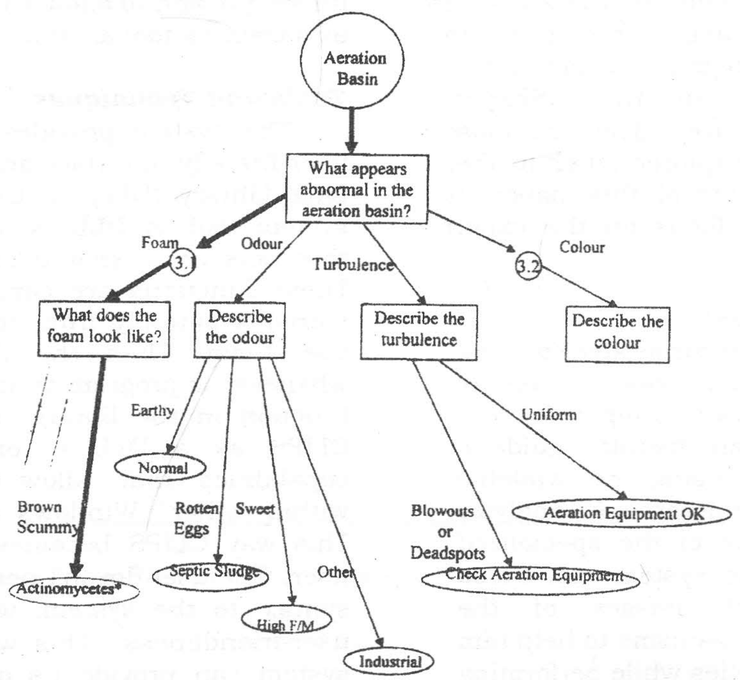


Figure 5 Initial Aeration Basin logic tree [9].

Database tool

The ASExpert system is also intended to perform full database functions in an easy way and no database programming skills is required to do so. The database tool is actually made up of three sub-systems. The data recording sub-system facilitates entering, storing and retrieving of the plant's daily measurements and test results. As the ASExpert system emphasizes the use of graphics a data graph component is also added. This graph tool allows the selection of variables to display and the type of graph to plot (pie, bar, lines etc.) in a flexible way. Graphic data forms are considered to be much more superior to tabled data. The human eye can easily recognize patterns this way and thus graphs provide an additional support to decision makers. Finally the report generator tool provides monthly reports of the required data. These three tools integrate to provide sound and reliable records for the plant's data. The database component represents a strong potential towards daily data recording through its easy to use data entry forms. Data can be easily maintained for the analysis of historical data or to satisfy any future need. Not to mention the extreme importance of the availability of reliable data if we were to integrate a simulation modeling component to the ASExpert system in the future. The database component won't be explored much further as the principal interest of this paper -as stated earlier- is to focus on the expert system module.

On-line help component

This component was incorporated to make the ASExpert system as easy to use as possible and to facilitate using it for self-training. It includes an operator guide to assist the user while using the available menus, performing microscope analysis and it explains some of the specialized terms used within the system etc. It also provides a set of images of the predominating microorganisms to help him identify the right species while performing the microscope analysis.

User interface

People's ability to absorb information and act upon it depends to a great extent on how that information is presented. The user interface is the system's component that determines the way for the user and the computer to communicate with each other. Graphical user interfaces (GUI) which add overlapping menus, use images, graphics, icons and colour present most of the system's options on the screen increase the friendliness of the system. GUI let users quickly grasp how to move around the environment. Therefore, using VC++5.0 a very flexible user-friendly interface is designed provided with menus, dialog boxes and property sheets to gather user's input plus answers to questions asked by the system. In doing so, the ASExpert system provides assistance to the user to choose the most suitable description to his problem from a set of feasible selections. The ASExpert system uses images of predominating microorganisms to help its users identify the results of a microscope analysis. No programming skills are required to use the system in order to encourage ordinary operators to use it frequently and to allow for using the system as a training tool as well.

Tools and Techniques

The system provides a Visual C++ 5.0 user-friendly interface and uses a Dynamic Link Library (DLL) of CLIPS as the expert system tool. A **DLL** is an executable file that acts as a shared library of functions. These functions are compiled, linked and stored separately from the processes that use them. Then the DLL is activated whenever a program or another DLL calls a function in the library. The ability to use CLIPS as a DLL is one of its strong capabilities that allow for using it from within other Windows applications [11]. This way CLIPS becomes invisible to the user. The user doesn't need to know CLIPS' syntax to the system, which adds to its user-friendliness. This way the ASExpert system can provide its own interface and the user is no longer tied to the standard

CLIPS interface that could be limited and unsuitable to handle a large program in a totally customized way.

A BRIEF DEMONSTRATION OF THE ASExpert SYSTEM

Whenever the user observes unusual evidence or detects abnormal results he can then start the system to seek advice. The system's advice will be related to the current state of the plant, the direction or trend of plant state change, appropriate control action to handle the current situation or further check tests that should be made.

A session with the ASExpert system

Case 1 Unusual foam in the aeration basin

Figures 6 and 7 represent the screen print-outs of the following case:

User Input

- roblem detection method = observations.
- ocation = aeration basin.
- bnormal feature = brown scummy foam.

Questions asked by the system are related to the following 2 aspects

- Percentage of scums covering the first 2 tanks.
- The trend of foam/scum change (increasing, decreasing or the same).

The user should select an answer for both questions from a set of available choices.

Figures 8 and 9 represent the screen print-outs when the user clicks the **"Trigger Expert System/Run and Display diagnosis"** menu selection. A notepad screen will display the results with the system's recommended action.

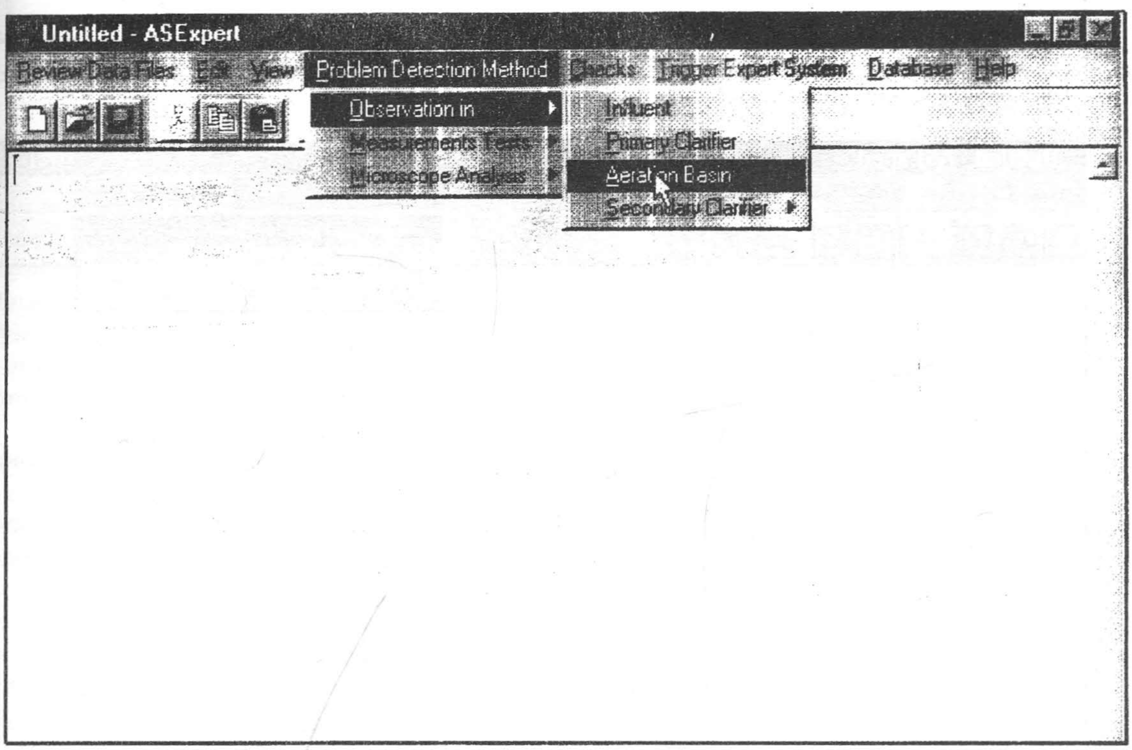


Figure 6 User should first specify problem detection method and location [11].

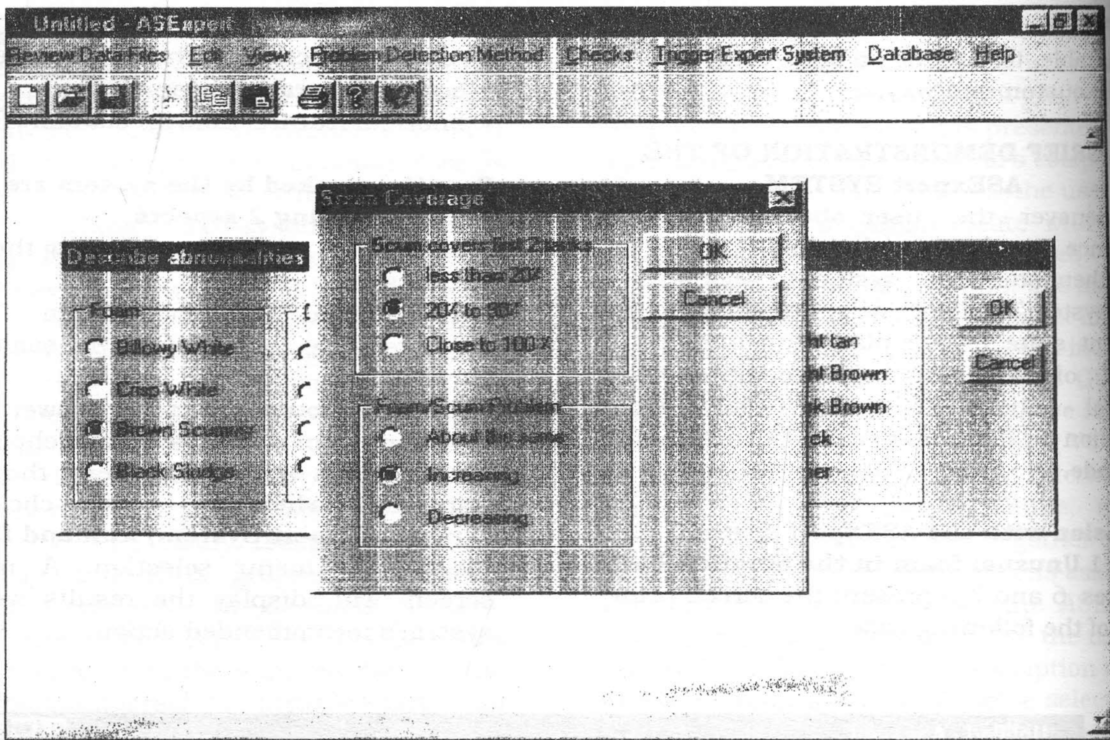


Figure 7 A dialog box appears to help the user describe the foam problem, then a second dialog box lets him further describe the current situation [11].

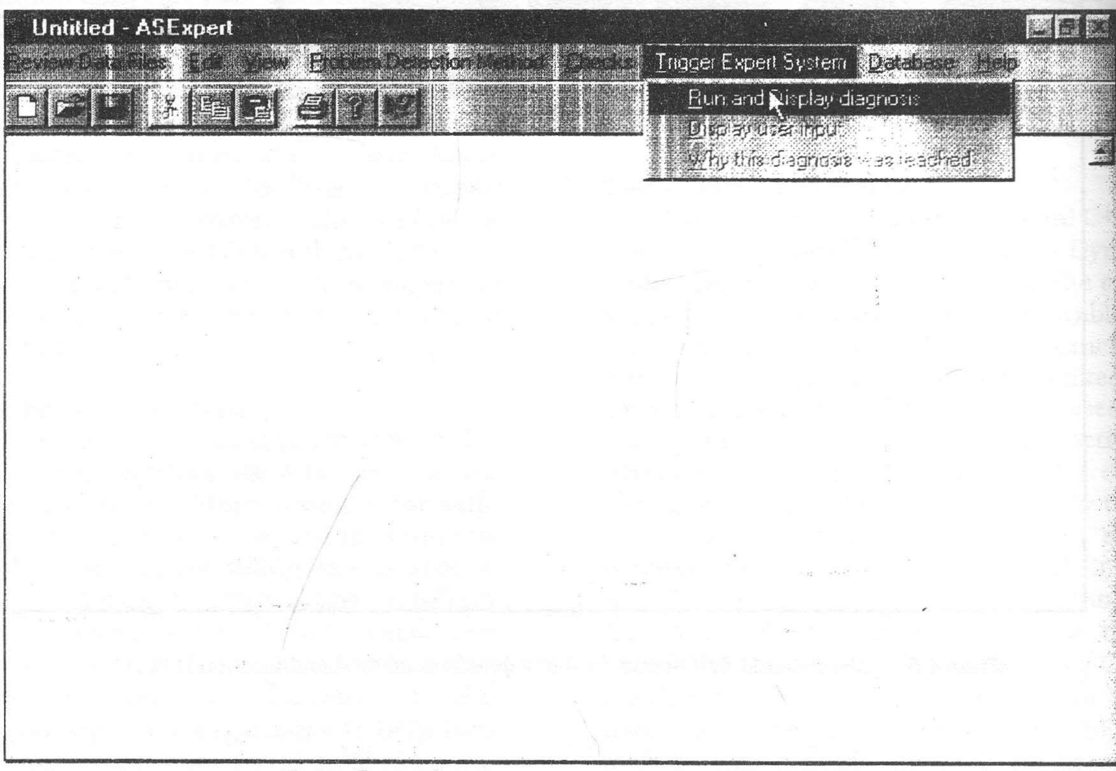
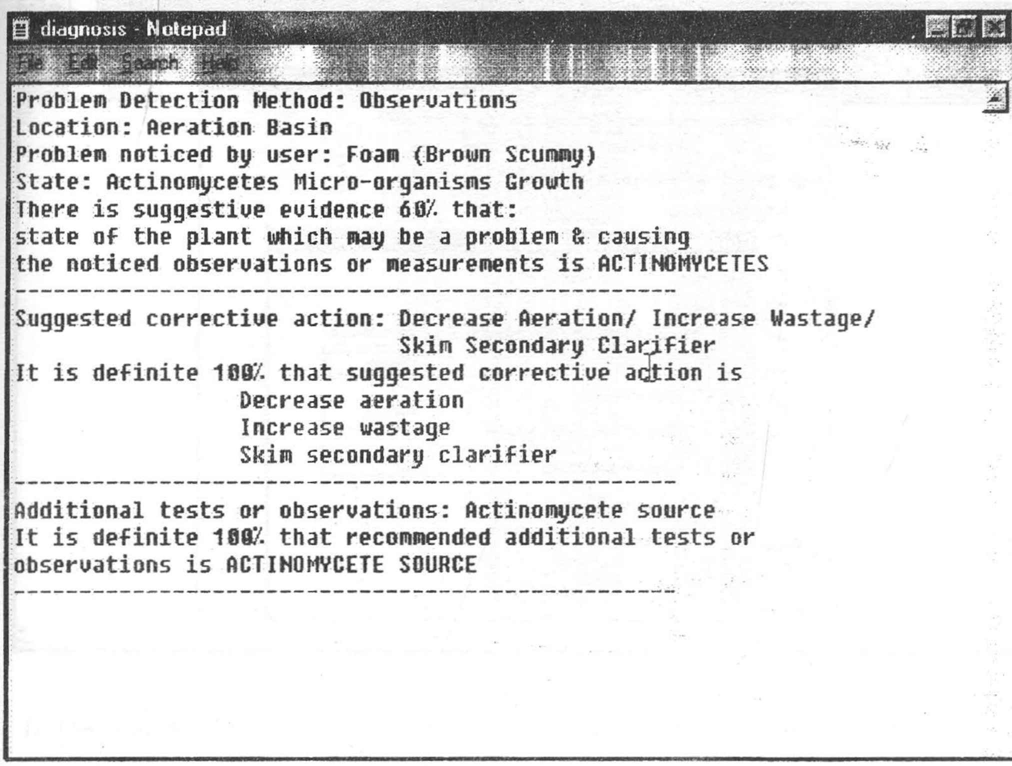


Figure 8 The user triggers the expert system [11].



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diagnosis - Notepad
File  Edit  Search  Help
Problem Detection Method: Observations
Location: Aeration Basin
Problem noticed by user: Foam (Brown Scummy)
State: Actinomycetes Micro-organisms Growth
There is suggestive evidence 60% that:
state of the plant which may be a problem & causing
the noticed observations or measurements is ACTINOMYCETES
--------------------------------------------------
Suggested corrective action: Decrease Aeration/ Increase Wastage/
                             Skim Secondary Clarifier
It is definite 100% that suggested corrective action is
                Decrease aeration
                Increase wastage
                Skim secondary clarifier
--------------------------------------------------
Additional tests or observations: Actinomycete source
It is definite 100% that recommended additional tests or
observations is ACTINOMYCETE SOURCE
--------------------------------------------------
```

Figure 9 A Notepad screen displays the conclusion reached by the system [11].

Case 2 investigating the results of microscope analysis

User Input

- Problem detection method = microscope analysis of sludge.
- Type of microscope analysis = microorganisms analysis.

Questions asked by the system

- A list of predominating microorganisms is provided and the user is instructed to choose a maximum of three or **(Not sure)** if he can't decide.
- A new dialog box asks the user to specify the microorganisms he is unsure about and lets him view the selection.
- Finally the image is displayed the user is instructed to confirm whether the image agrees with the microscope result or not.

Figures 10 and11 demonstrate the case; the user is provided with a set of the predominating microorganisms. As he checked the **(Not sure)** check-box, a second dialog box appeared to enable him view the image of the predominating microorganisms he chooses. The image he chose (amoebae) is displayed and he is asked to make a final confirmation of this choice. This way the system helps the user pick the selection most suitable to the current microscope results.

The ASExpert Trigger Expert System menu options [11]

This menu is actually the heart of the expert system module. The following flow chart Figure 12 explains how the three selections of the (Trigger Expert System) menu fulfill the user's requirements. It also helps us understand the sequence of actions that take place whenever the user invokes the expert system module for any general case.

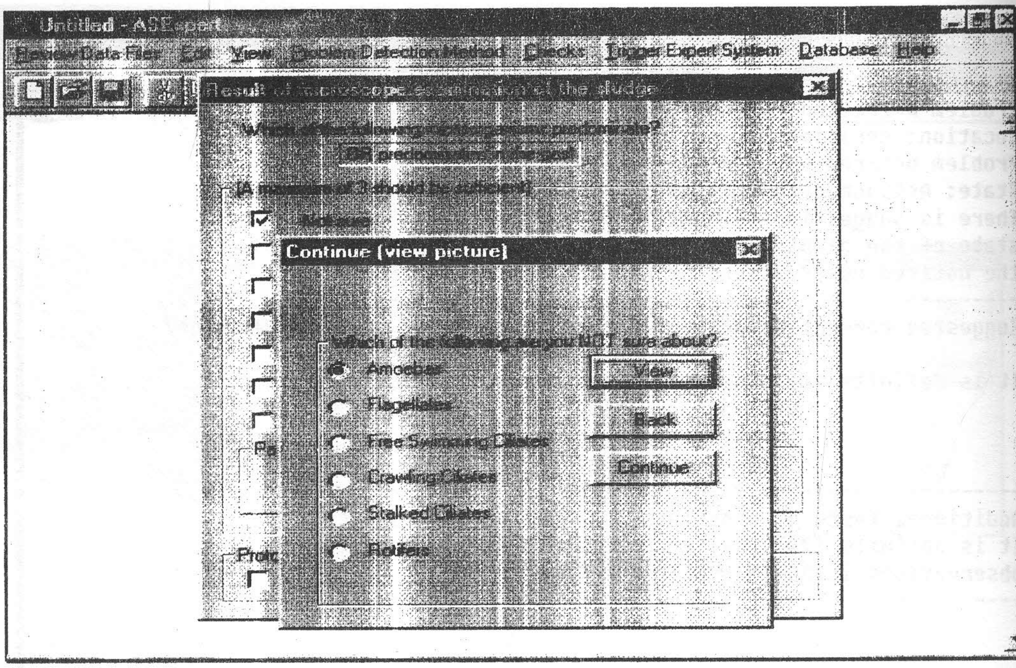

Figure 10 The user first checked the (Not sure) check box then chose to view the image of amoebae [11].

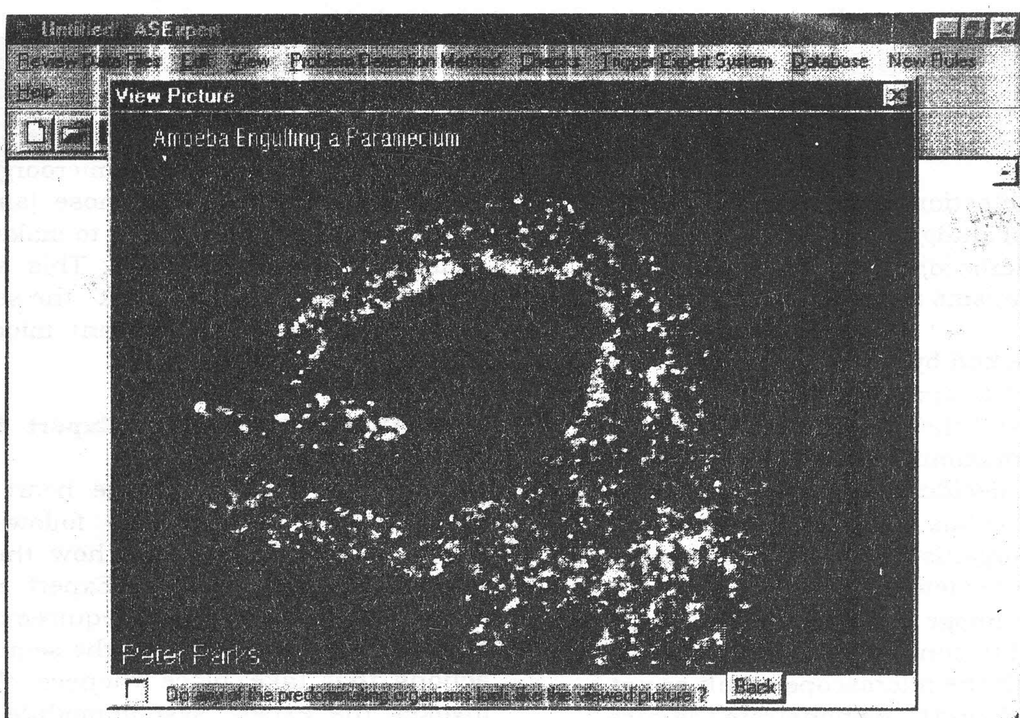

Figure 11 Here the system asks the user to confirm whether the predominating microorganisms look like the displayed image or not [11].

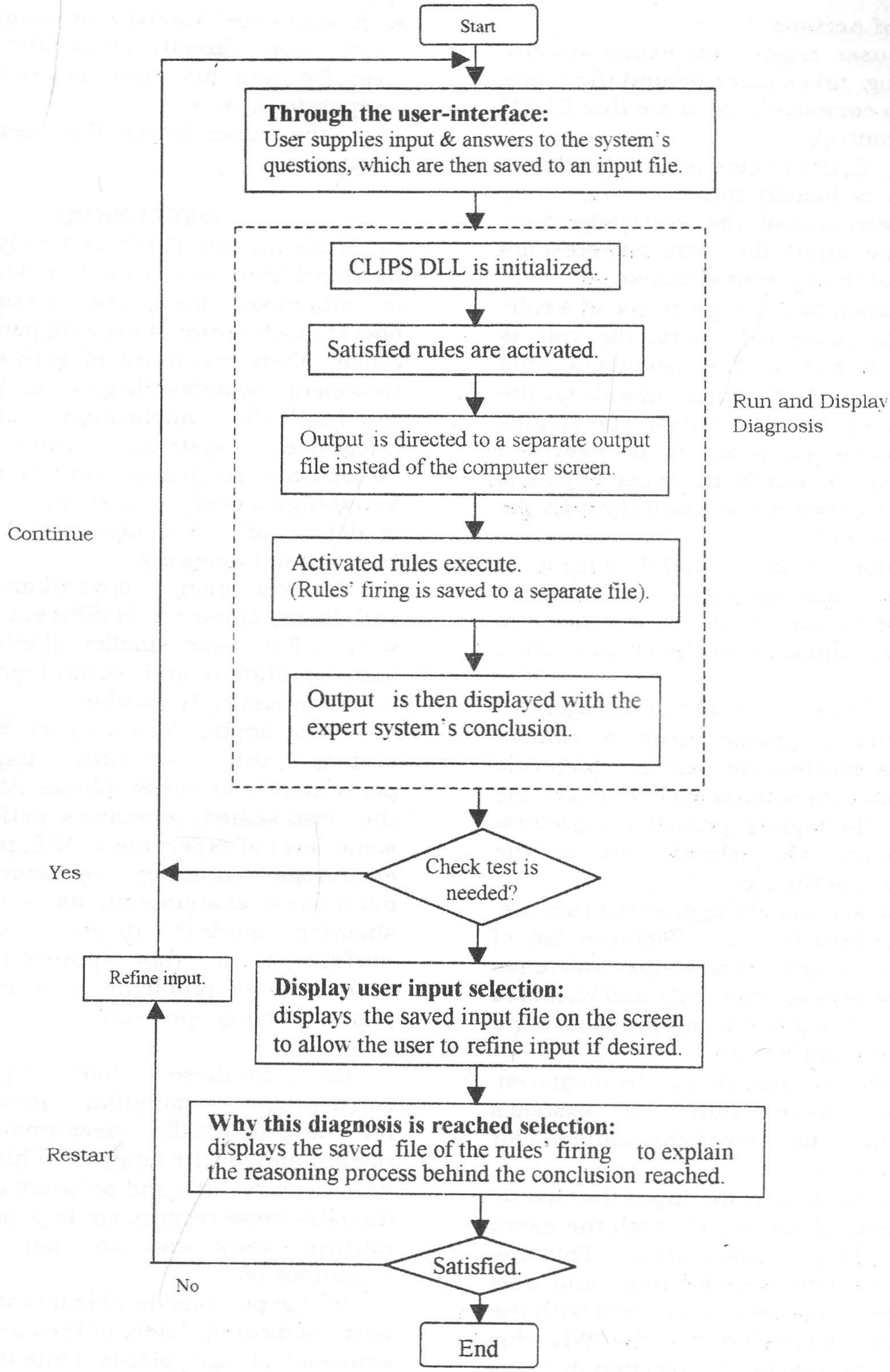

Figure 12 A flow chart of the "Trigger Expert System" menu.

Sequence of Actions

When the user triggers the expert system, the following takes place behind the scene (the user is completely unaware that CLIPS has taken control):

- First the CLIPS engine is initialized and the DLL is loaded into memory, along with a selection of the knowledge-base files & the input file, which represents the facts of the current situation.
- Second when all the patterns of a rule match the supplied facts, the rule is activated & put on the agenda (agenda according to CLIPS' syntax stands for the collection of satisfied rules). The actions of applicable rules are to be executed only when the CLIPS' inference engine is instructed to begin execution through the (Run command).
- Third before running CLIPS, output is directed to a specific output file instead of the standard output (computer screen). This way it could be displayed as & when needed.
- When multiple rules are in the agenda, the inference engine uses a conflict resolution strategy to select which rule should have its actions executed first The rule with the highest priority will fire first i.e. execute the **(then)** part or the consequent of the rule.
- When the actions of the selected rule are executed (which may affect the list of applicable rules) then the inference engine selects another rule and executes its action. This process continues until no applicable rules remain.
- Finally, the output file can be displayed on the screen with the system's conclusion and recommendations for further actions.
- The user can review the input that led to the present diagnosis through the menu selection "Display user input". This way he could further refine his input and start a new session if he isn't satisfied with the current diagnosis. Whereas the "Why this diagnosis is reached?" selection displays the rules' firing on the agenda to explain the reasoning process that led to the present conclusion.
- Through the "Notepad" program the user can also directly print the system's results and his input or save them to separate files.
- As the user leaves this menu CLIPS exits.

CONCLUSIONS

Since the late 1980s and early 1990s the technical literature began to reflect a change of emphasis from the design to the operational control of existing plants.
Since then the trend of activated sludge treatment systems began to be directed towards the application of multiple integrated systems. These systems incorporate analytical control methods, a knowledge-based system, simulation modeling and a database tool all in one conceptual framework.

However, many conventional plants are still being operated in different parts of the world. For some smaller plants advanced instrumentation and control may not prove to be economically feasible.

Using applications such as the ASExpert system will certainly improve the performance of these plants. ASExpert lets the less-skilled operators perform at the same level of expert ones. ASExpert can also encourage ordinary operators to use microscope examination as a rapid trouble shooting guide. Currently despite the usefulness of this approach for quick evaluation of problems, it is not yet very popular among operators.

Its database tool represents a considerable potential towards daily recording of routine measurements & test results and for the analysis of historical data based on reliable and accurate data records (usually these records are kept as part of the routine work and are not fully taken advantage of).

In Egypt considerable investments have been dedicated lately to the construction of activated sludge plants. Thus the economic implications of applying systems such as ASExpert can be substantial in both time and cost savings especially when compared with the overall cost of plant shut-downs which can be inevitable in some plant failure cases.

Not to mention the capital cost savings as improved operation naturally helps deferring the need for plant expansion and acts as a safe guard against damaging the environment.

Finally integrating the CLIPS shell to a Visual C++ interface leads to a powerful application that can be continuously maintained to satisfy future needs.

REFERENCES

1. J. F. Andrews (Ed.), "Dynamics and Control of the Activated Sludge Process", Water Quality Management Library-Vol. 6, Technomic Publishing Company, Inc., Lancaster, Pennsylvania, U.S.A., (1992).
2. G. Tchobanoglous, and F. Burton, (Eds.), "Wastewater Engineering: Treatment, Disposal and Reuse." Rev. ed. of Wastewater Engineering / Metcalf and Eddy Inc. 2nd ed. 1979, McGraw-Hill Series in Water Resources and Environmental Engineering, 3rd Ed., (1991).
3. R.A.B. Gall, and G.G. Patry "Knowledge-Based System for the Diagnosis of an Activated Sludge Plant". In Dynamic Modeling and Expert Systems in Waste-Water Engineering (Eds. G.G. Patry and D.T. Chapman), Lewis Publishers, Inc., Chelsea, Michigan, U.S.A., (1989).
4. *P. Serra, M. Sanchez, J. Lafuente, U. Cortes, and M. Poch, "ISCWAP: A* Knowledge-Based System For Supervising Activated Sludge Processes", Computer Chem. Engng, Vol. 21, No. 6, pp. 211-221, (1997).
5. R. M. Tong, M. R. Beck, and A. Latten, "Fuzzy control of the activated sludge wastewater treatment process", Automatica, Vol.16, pp. 659-701, (1980).
6. P.M. Berthouex, W. Lai, and A. Darjatmoko, "Statistics-Based Approach to Wastewater Treatment Plant Operations." Journal of Environmental Engineering, ASCE, Vol. 115, No. 3, pp. 650-671, (1989).
7. N.H. Ozgur, and M.K. Stenstrom, "KBES for Process Control of Nitrification in Activated Sludge Process." Journal of Environmental Engineering, ASCE, Vol. 120, No. 1, pp. 87-107, (1994)
8. PC AI, "Expert Systems Resources", Internet address http://www.pcai.com/pcai_Home_Page/ai_info/expert_systems.html
9. R.A.B. Gall, and G.G. Patry, "Knowledge-Based Systems in Wastewater Engineering", Report No. 88-GP-01, Department of Civil Engineering, Environmental Systems Engineering, McMaster University, Hamilton, Ontario, Canada, (1988).
10. R.A.B. Gall, and G.G. Patry, "Knowledge-Based Systems in Wastewater Engineering-Technical Appendix", Report No. 88-GP-02, Department of Civil Engineering, Environmental Systems Engineering, McMaster University, Hamilton, Ontario, Canada, (1988).
11. L. Bahgat, "A Knowledge-based Decision Support System for an Activated Sludge Wastewater Treatment Plant", Thesis to be submitted for M. Sc. in Information Technology (under *preparation), Institute of Graduate Studies and Research, Alexandria* University,
12. CLIPS On-Line Documentation, Internet Address http://www.ghg.net/clips/download.

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نظام متكامل قائم على المعرفة لدعم اتخاذ القرار بمحطة لمعالجة مياه الصرف الصحي بواسطة الحمأة المنشطة

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ملخص البحث

تستخدم عملية الحمأة المنشطة على نطاق واسع بالعالم أجمع في أعمال المعالجة الثانوية لمياه الصرف الصحي. تتميز هذه العملية بالقدرة على تحقيق كفاءة أداء عالية، غير أنها معروفة أيضا بصعوبة التشغيل و التحكم بسبب عدم المعرفة الكاملة حتى الآن لتقنية النشاط البيولوجي المصاحب لها و لأن المعلومات المستخدمة بها تكون مبنية على بيانات وصفية.

و لهذا فقد اتضحت مبكرا حاجة مشغلي محطات الحمأة المنشطة لاستخدام وسائل مناسبة ذات كفاءة عالية لتعويض هذه المعرفة الناقصة بواسطة الخبرة البشرية. و عليه تم البدء في تطبيق النظم الخبيرة بهذه المحطات.

و الغرض من هذا البحث هو تقديم شرح موجز لمكونات النظام الذي أطلقنا عليه اسم ASExpert و هو نظام تجريبي متكامل قائم على المعرفة لدعم اتخاذ القرار يتكون من نظام خبير بالإضافة لنظام كامل خاص بأعمال قواعد البيانات مخصص لمشغلي محطات الحمأة المنشطة.

يركز هذا البحث بصفة أساسية على إظهار إمكانيات النظام الخبير و التكنيك الذي استخدم في تطويره. و قد توصل إلى النتيجة الآتية و هي إن تكنولوجيا الأنظمة الخبيرة قد أثبتت كفاءتها في تحسين كفاءة تشغيل محطات المعالجة. أما بالنسبة لمصر - حيث يتم الآن توجيه جانب كبير من الاستثمارات نحو إنشاء محطات معالجة بواسطة الحمأة المنشطة - فإن تطبيق النظام ASExpert سوف يؤدى إلى التشغيل الأمثل للمحطات و يمكن أيضا استخدامه في تدريب المشغلين الجدد و بالتالي سوف يعمل على زيادة العائد الاقتصادي لهذه الاستثمارات.