THE CHANGING ROLE OF OPERATIONS STAFF IN DESIGN OF WASTEWATER TREATMENT PLANTS

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ABSTRACT

Recent changes in the detailed design procedures for wastewater treatment plants over the last ten years have resulted in increasing input from operations staff. Formal inclusion of operational input includes HAZOP's for most projects, workshops and endorsement procedures for alliances and HACCP for plant monitoring and optimisation.

In addition to the formal processes being adopted, there is also an enormous collective experience held by operations staff. Operational staff have continuous exposure to performance and reliability of systems. This exposure and experience is usually not available to designers and many suppliers.

Examples are presented of beneficial operational input to the above processes. Further opportunities for operational input to the design process are then identified including process design, control and plant layout.

1.0 INTRODUCTION

Under the traditional delivery method for wastewater treatment plants of design and documentation by a consultant, calling of tenders, construction by a civil contractor, installation of electrical and mechanical equipment by various contractors, a token commissioning and then "handover" for process optimisation, there was little opportunity for input to the design process by operations staff. Lack of budget for consultation or lack of flexibility though the use of "standard designs" were often used as reasons to deny the opportunity for operations input. Indifference or unwillingness to acknowledge a source of more extensive or superior knowledge may also have been possible reasons for lack of this consultation.

However, with the advent of revised design quality assurance procedures such as HAZOPs and revised delivery procedures such as alliances, not only has the opportunity for operations input been increased, it some cases it is mandatory. This is placing more emphasis on operations staff to play a role of increased responsibility. Only a few operators have the opportunity to be involved in the design process on more than one occasion in their working lifetime.

Formal procedures for operations input are described to provide a background for future projects by operations staff. More importantly, potential additional areas for operations input are identified that can lead to more operable, more reliable and therefore more economic plants to the benefit of designers, operators and owners.

2.0 DESCRIPTION

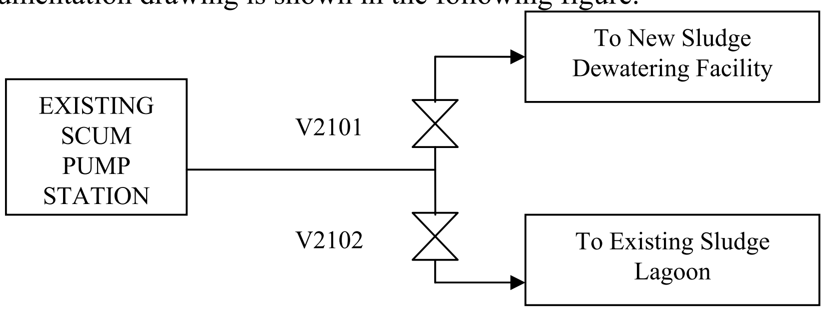
2.1 HAZOP Procedure

The Hazard and Operability procedure became more common in the wastewater industry during the mid to late 1990's.

Originally applied for internal design review, it became more widely applied in Design and Construct forms of project delivery in an effort to overcome "short cuts" in design and project delivery.

The HAZOP's procedure generally makes use of the Process and Instrumentation Drawings (PID's). A unit process such as the secondary clarifier or sub-unit process such as the scum pump station is evaluated in detail using prompt words such as "high level", "high pressure", "reverse flow", "no flow" and "high temperature". The study is carried out in a group environment and this assists in "sparking" comments and ideas from other members of the group. This "sparking" or "bouncing" of ideas is a common theme for many of the effective design development or review processes.

An example of a HAZOP is the case of a scum pump station that can pump to either the sludge dewatering belt presses or to the sludge lagoon. The sludge dewatering system is an augmentation to the pumping system to the existing lagoons. A simplified process and instrumentation drawing is shown in the following figure.



<u>Figure 1:</u> ***Simplified PID for HAZOP***

The findings from the HAZOP and the proposed rectification measures are presented in the following table.

<u>Table 1:</u> ***HAZOP's Findings and Rectification Measures***

Test	Finding	Rectification
1. High Pressure	V2101 and V2102 closed.	1. Actuate valves and install limit switches to ensure that one valve is always open.
		2. Provide separate pumps and separate pipelines to belt presses and sludge lagoons
		3. Implement operational procedures to confirm that one valve is open before enabling scum pump station pumps.
2. Reverse Flow	Sludge lagoon is higher than belt presses and flow can occur from lagoon to belt presses.	1. Install non-return valve in line to sludge lagoons to prevent back flow.
		2. Provide siphon breaker on line to sludge lagoon.
		3. Provide free discharge into sludge lagoons.
		4. Provide separate pumps and separate pipelines to belt presses and sludge lagoons

The selection of the rectification to the first test of "high pressure" could be based on economic criteria. However, the second issue of "reverse flow" requires modification of the design. Whereas options 1, 2 or 3 potentially represent the lowest cost, option 4 can address both of the test issues encountered.

Thus a rigorous evaluation can identify multiple issues that can be addressed by the single solution.

The operator's knowledge that the flow can siphon from the existing sludge lagoon (from when repairs were done to the rising main prior to the belt press system being added) avoided a potentially disastrous situation.

Local knowledge can therefore add immensely to the design process. (This example is based on a real life situation however, both the belt press facility and the scum pump station were new thus no operating experience was available. The plant operator did however apply logic to identify the situation-something not applied by the design engineer). In this case, prior experience is not essential; simply the application of logical thinking is all that is needed.

2.2 Alliance Procedures

The HAZOP procedure is designed to rectify potential problems once the preliminary design has been carried out. This potentially denies the opportunity to generate the optimum solution at the outset that may be superior to some remedial measure identified in a HAZOP study. The alliance process has the potential to overcome these limitations by involving operations staff earlier in the design process.

The Alliance process involves all parties in the entire project delivery process. Whereas it is not expected for operators to get directly involved in the detailed design of the facilities, there are extensive opportunities for comment and direct input. These include the endorsement process and workshops.

The endorsement process involves the designer preparing a report and/or drawings for review and "endorsement" by the client organisation. Such material may comprise the civil layout for the bioreactors and secondary clarifiers or the preliminary treatment area or a design report on the aeration system to be used, the solids dewatering system to be used or the final effluent disinfection system to be used. This material is reviewed and constructive criticism is provided by all team members. Such constructive criticism may comprise recommendations to modifications to layout, provision of maintenance devices such as permanently mounted lifting davits or use of alternative equipment such as centre drive thickeners as against peripheral drive devices.

It is not essential to accept material presented for endorsement in its entirety or even partially. Suggestions can be made for improvements. However, acceptance is based on consensus of the Alliance Project Management Team only and not all participants in the project. Typically there is direct or indirect representation of operations staff on the Alliance Project Management Team in addition to members that respect the opinions of operations staff.

The second avenue of input to a project is through workshops. Workshops can be held at any time and for any reason. Usually workshops are held for such topics as "innovation" of plant layout, bioreactor configuration or solids handling. Other more specific workshops can be held as problems arise.

Examples may include commissioning and start-up, temporary decommissioning and modification of existing plant or major equipment installation. The format of the workshop can vary dramatically from presentation and vote type proceedings to multi-group development of approaches. Virtually any format can be used. However, to be effective, the principle of "no idea is a bad idea" must be adhered to and bringing forward all ideas must be encouraged. Again, an environment of open discussion must have been fostered previously to maximise the benefits of a workshop.

The number of beneficial ideas that have been generated in alliance workshops are numerous. Often a simple or passing comment sparks further conversation or ideas. As this simple comment is developed, highly beneficial or cost saving solutions are developed at the early stages of design. The opportunity afforded by workshops should be fully embraced by all participants.

2.3 General Observations

Anyone can make general observations during construction or augmentation of a plant. Not everyone necessarily thinks fully about these observations. The opportunity does however need to be made available to point out these observations to the appropriate person (one that will listen). The ability to communicate with the right person usually relies on having established some form of relationship previously. Frequent examples can again be quoted. A number of these relate to hydraulic constrictions in plants (points of high level or overflow) that reduce wet weather flow capacity. These observations prove invaluable in confirming or revising hydraulic designs. Similarly, poor flow division leading to uneven loading of process units can be identified and rectified to permit the full plant capacity to be realised.

No one is precluded from making observations. Again, the application of logic is often all that is required. It helps if the right person listens.

2.4 Pro-Active Opportunities for Operations Input

The above inputs to the design process primarily focus on taking someone else's idea and commenting on it to improve it. This is a substantially reactive process. There is an enormous opportunity for operations staff to take a proactive approach to influence designs from the start.

A number of case examples are presented to demonstrate where operating experience can potentially contribute to the improved performance of a treatment plant. These examples are considered to be beneficial by the author and do not necessarily represent any endorsement of any product or company.

Dissolved Oxygen Probes

Any activated sludge plant or aerobic digestion system relies on accurate dissolved oxygen control for maximum performance and minimum energy consumption. Most activated sludge plants and aerobic digesters operate at dissolved oxygen concentrations from 0.3 mg/L to 3 mg/L. Unfortunately, most dissolved oxygen probes are calibrated in air at a dissolved oxygen concentration of approximately 10 mg/L.

A drift in the zero point for the dissolved oxygen probe can result in significant errors in actual readings and therefore actual performance. Dissolved oxygen probes that experience minimal drift in the zero value may therefore be preferred for many applications.

However, it is not just sufficient for a dissolved oxygen probe to have minimal drift in the zero point, it must also be have a reliable membrane resistant to damage and also be resistant to fouling. Self cleaning membranes are an additional advantage in maintaining accuracy of dissolved oxygen readings.

Few, if any, designers have the opportunity to observe dissolved oxygen probes in-situ whereas it is becoming more common for operators to undertake side by side trials before

replacing dissolved oxygen probes.
The additional cost of a dissolved oxygen probe with lower end accuracy and self cleaning features is readily justified in terms of power savings and performance in biological nitrogen and phosphorus reduction plants.

Pumping Equipment
One client had a distinct preference for rotary lobe pumps as against other forms of positive displacement pumps. As this particular project required a large number of positive displacement pumps (20 in all) the potential cost savings in using other than rotary lobe pumps was significant (although not large in the overall project costs). The pump selections were critically reviewed at the endorsement phase to ensure that appropriate selections were made. Further more, the client specified that positive displacement pumps were to be restricted to 300 rpm to reduce wear and tear that can occur with lower cost, higher speed devices.

This is a clear example of where operations and maintenance staff were able to influence initial capital cost savings for the longer term overall savings and plant reliability.

Control parameters
Many devices require optimised control settings for effective operation. Grit removal facilities in particular requires parameter settings based on experience. Suppliers often do not have a clear idea of optimal settings and do not have the opportunity for long term optimisation unlike operations staff. Other interactive devices such as belt presses or centrifuges have a clear need for experienced optimisation to achieve optimal performance. An increase in cake solids from 12% to 15% can represent annual cost savings of the order $75,000 for a 60,000 EP plant.

Protective coatings
I have personally been asking almost every operator that I meet, have they found a good paint for clarifier launders that prevents algal growth. There appears to be a good one (does not prevent growth but reduces it) found by operational staff. Still awaiting further updates.

Research
Research or discoveries by operators have resulted in some of the most significant advances in activated sludge treatment. Nitrification was discovered by operators; denitrification was discovered by operators; biological phosphorus removal was discovered by operators.
There is still major work to be done on biological phosphorus removal and much of this will come from full scale plant operations.

Filamentous bulking minimisation is an area of further current research where plant operations are expected to play a vital role in developing practical control solutions. Investigations are currently being carried out at a number of plants.

The role of protozoa in activated sludge has been poorly researched with papers on selection criteria ignoring fundamental characteristics of the protozoan population. The early teachings of operators have provided good direction for modelling and increased understanding of the role of protozoa.

Education
Water and wastewater have never before enjoyed such a high profile. With school tours, media visits and interest group tours, the treatment plant operators are usually the initial, and frequently the only, industry contact.

The role of operations staff in education either directly or as a source of educational material can be expected to become increasingly important. Although not a direct influence on design, education will influence the requirements for treatment plants in terms of performance and reliability.

Performance

The actual performance of plants influences design in as much as long term performance influences the EPA discharge limits. One merely has to assess the typical nutrient discharge limits in Victoria, New South Wales and Queensland to determine that perceived performance capabilities have determined discharge limits rather than actual environmental criteria.

3.0 CONCLUSIONS

The Water Industry Operators Association is an association primarily aimed at benefiting its members. Many definitions exist for an association however, possibly one of the most applicable is "An organization that an individual uses for many reasons including socialization to a profession, networking, professional development, and for gaining "understanding, recognition, and knowledge in the field; to develop and promulgate standards for professional practice; to serve the public interest; and to provide professionals with a peer group that promotes a sense of identity" (Nuss, 1993, p. 365). The emphasis is on gaining knowledge, knowledge transfer through networking, promulgate standards, to serve the public interest and promote a sense of identity.

The members of the Water Industry Operators Association have a tremendous potential to influence the future of the industry by demanding more cost effective solutions on the small scale such as dissolved oxygen probes or on the large scale in terms of process configuration or plant layout. The collective knowledge of the members can be used to demand higher performance and reliability of equipment and drive suppliers to develop or source more cost effective solutions.

The opportunity for some members to experiment with equipment and processes also has the potential to save the industry literally millions of dollars per year in chemical costs, power costs and sludge disposal costs. Savings in maintenance are difficult to quantify however, the potential has to be at least significant.

4.0 RECOMMENDATIONS

It is recommended that the WIOA create a list of areas where operations experience can contribute to improved design procedures, equipment selection, operation of equipment, selection of protective coatings and materials of construction. .

5.0 REFERENCES

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