

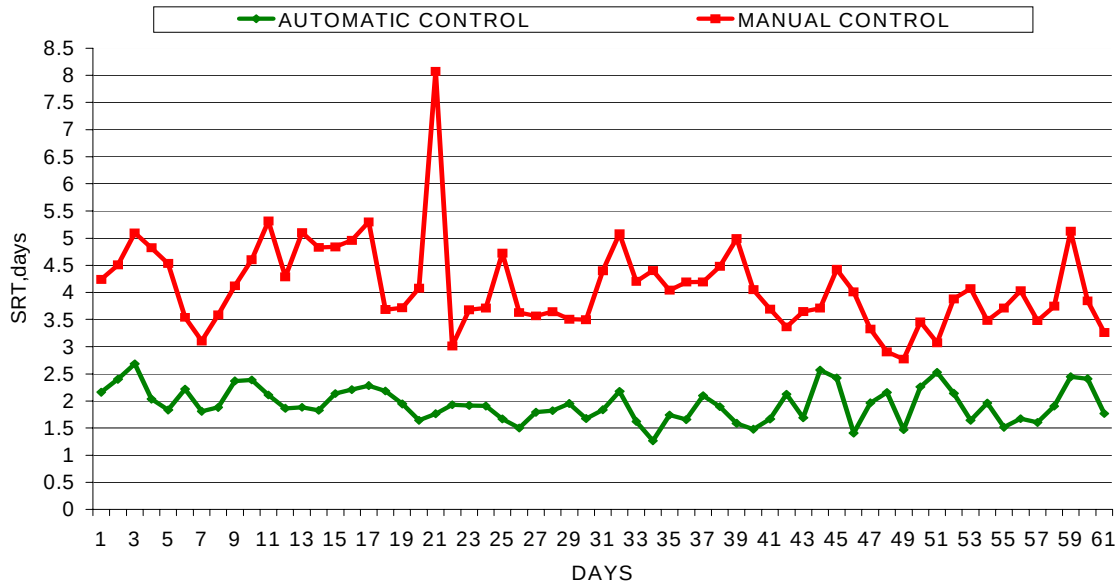
PROCESS OPTIMIZATION AND AUTOMATION IMPROVES RELIABILITY AND COST EFFICIENCY OF OXNARD WWTP

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32 MGD Oxnard wastewater treatment plant employs the following liquid treatment processes: primary clarification, trickling filters, solids contact, secondary clarification and chlorination. The solids treatment processes consist of primary sludge gravity thickening, dissolved air floatation with polymer addition, anaerobic digester and mechanical dewatering with polymer addition. Average effluent TSS is 5mg/l, 95% percentile of effluent TSS is 10mg/l. The plant staff has been continuously searching for innovative methods to improve process performance and cost efficiency of operation. As a part of a continuous improvement process the plant has started implementing process optimization and automation program for an activated sludge process.

In 2003 the plant has implemented sludge age optimization and automatic control provided by Ekster and Associates. Based on analysis of historical data it was determined that an increase of sludge age leads to an increase to SVI. It was also concluded that an increase of SVI leads to an increase of effluent TSS. Based on detailed analysis of historical data it was recommended to reduce target sludge age value from 4.5 days to 2 days. The automatic sludge age control system (ASACS) was able to maintain this value with standard deviation of less than 0.1 days. (Fig.1).

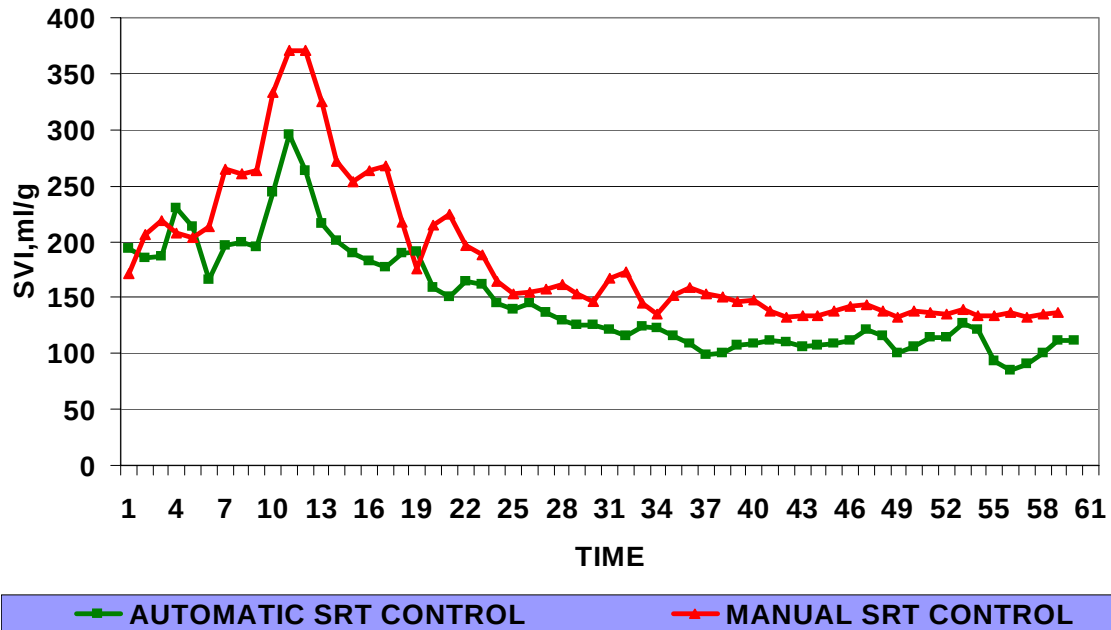
Fig.1 Maintenance of the old SRT set point using manual control vs. maintenance of the new SRT set point using automatic control.



After sludge age has been optimized and automated sludge age control was implemented the performance of the plant has improved. The foam usually observed from time to time during summer months has never been observed during summers of 2003, 2004. Settling volume index (SVI) was reduced on average from 150ml/g to 120ml/g. Even during times of high BOD load discharged by agricultural industry the ASACS was able to mitigate a negative effect of the load on SVI (Fig2).

In addition ASACS has stabilized mass load on thickening facility. As a result of these improvements effluent TSS was reduced down to 4 mg/l, polymer usage for thickening was reduced by 25%, and energy use was reduced by 3.9%. In addition to improvements of water quality and cost efficiency of operation ASACS has improved operational reliability. For example, several times ASACS has provided an alert indicating a considerable misbalance between mass of wasted solids and a change in aerobic biomass. ASACS has provided potential explanations of this phenomenon.

Fig.2 SVI before and after implementation of SRT optimization and automation



One of such explanations was a considerable increase of clarifier sludge depth. Based on this information an operator has measured sludge depth in all clarifiers and found eight feet of sludge blanket in one of the clarifiers due to plugging of a returned sludge line by snails or flights failure. Another time when sludge depth in clarifiers has been increased due to malfunction of sludge collection mechanism ASACS also provided to appropriate warning to operators.

Based on success achieved by optimization and automation of sludge age the plant has decided to optimize and automate air supply to the activated sludge system using dissolved oxygen control system (DOCS) and optimization services provided by the same vendor. An original DOCS was commissioned by Turblex (blower manufacturer) in 1990. Unfortunately, due to excessive valve and blower vane oscillation the control system was turned off right after commissioning, and no automatic control of either

valves or blowers was used since then. A change of operation from a completely manual operation to DOCS was a significant step forward, especially considering a negative experience that operators and plant management had with automatic D.O. control. In order to initiate automatic control the plant has recalibrated all D.O., airflow meters, and actuators. A plant aeration system was modeled using Matlab/Simulink computer model. Results of the modeling have revealed that original pressure based control of the blower could not be utilized due to stability problems of the control system. As a result pressure based control concept was replaced with a concept of utilization of historical database and Case Based Reasoning methodology. The idea of this method is finding in historical database records closest to current conditions and retrieving operational parameters such as blower vane opening that provided minimum energy used by the blower, while required D.O. set points are maintained. In order to seed the database most open valve methodology has been applied.

To determine performance of the new control system a snapshot of D.O. readings by the meter during one hour at constant airflow was taken before placing the D.O. control system in operation. This snapshot revealed that coefficient of variation is 20%. When D.O. control system was placed in service the coefficient of variation was 22% i.e. most of D.O. variation was caused by the measurement noise not oscillation of the control system. At the same time airflow demand changes over a 24 hour period by a factor of 2 (Fig.3). Review of valve and blower vane position data confirmed that there were no oscillations (Fig 4). The plant staff realized that in order to be successful DOCS should be not only efficient but also reliable. The DOCS utilizes efficient fault detection algorithms and fail-safe control algorithms to provide required reliability.

Fig. 3 D.O. and airflow in one of the compartments during a 24 hour period

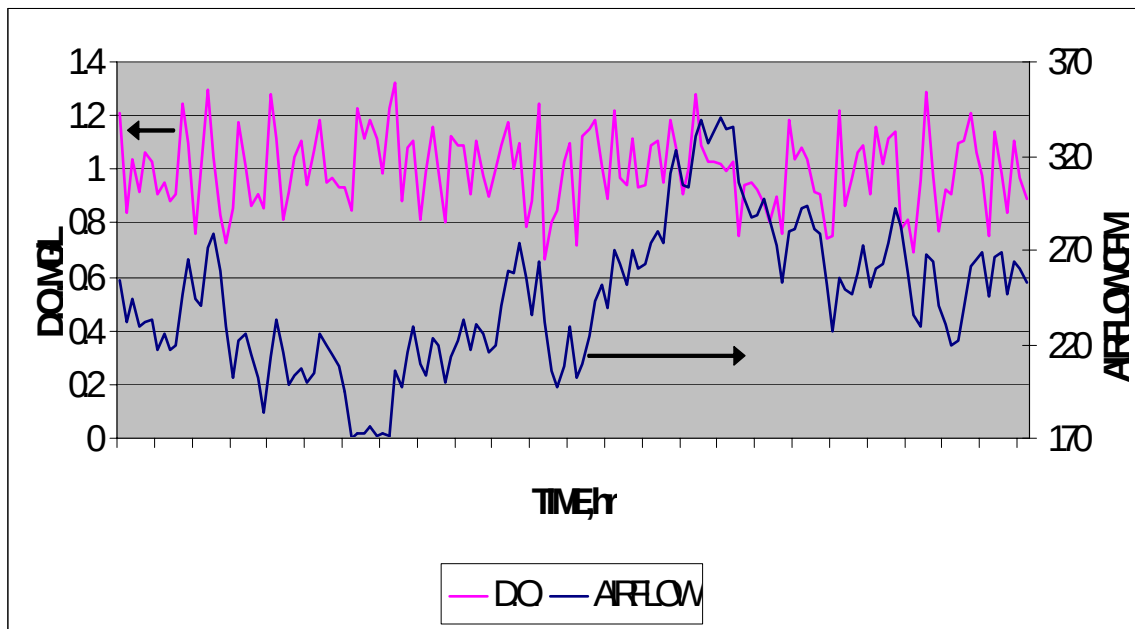
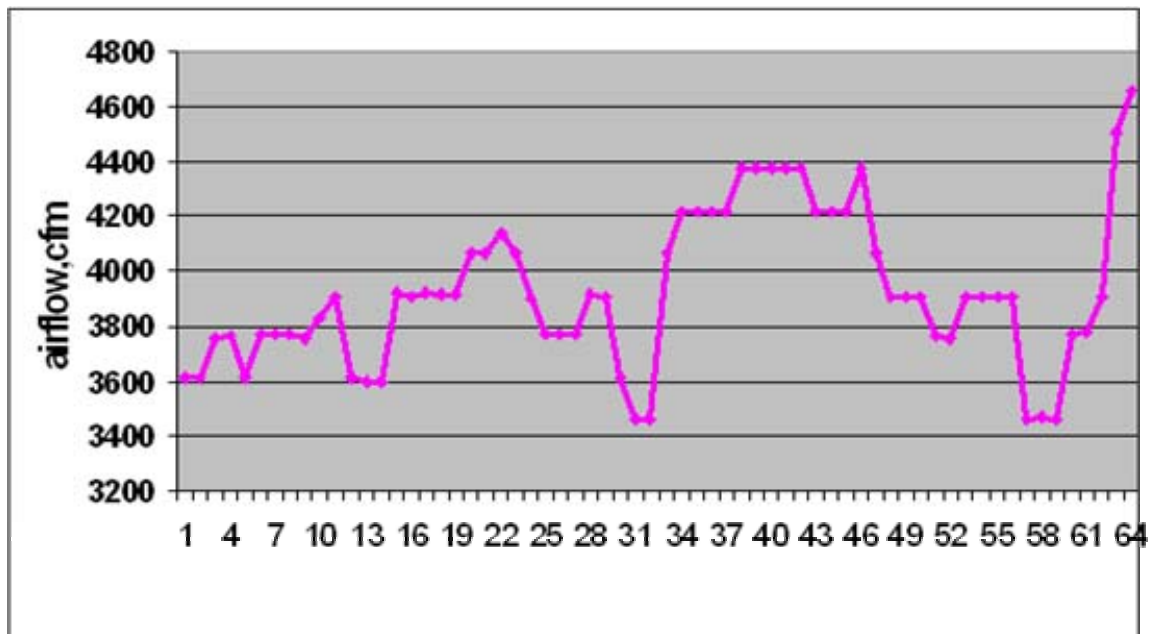


Fig. 4. Performance of the blower during a 24 hour period



During first several months of operation reliability of DOCS was challenged. However, an actuator fault detection algorithm and D.O. algorithm were able to detect problems on-

time, provide necessary alarms and switch to fail-safe algorithm and avoid considerable waste of energy and over pressurizing the aeration system.

In addition to implementing DOCS D.O. set points optimization has been under way. Selection of D.O. set points is based on the activated sludge performance and energy demand. The goal is to strike a perfect balance between water quality, settling characteristics and energy demand. The staff realizes that similarly to SRT set point selection this work is a continuous improvement process due to the fact that influent characteristics, water temperature and treatment efficiency of upstream treatment processes change frequently. Comparison of blower energy demand in August 2003 (manual control) vs. August 2004 (automatic control) showed that D.O. optimization and automation program has reduced energy usage by 15-30%. In addition SVI have been further reduced down to two digit level significantly improving not only clarification reliability but also performance and cost effectiveness of dissolved air floatation thickener. Implementation of both control system was performed with minimum outside help and saved the Plant dozens of thousands of dollars.

CONCLUSIONS

1. Process optimization and automation can benefit any treatment plant, even if the plant already provides excellent water quality.
2. Selection of set points is a continuous process and should be considered as such.
3. Automatic maintenance of set points is a challenge that can be overcome using advanced control algorithms and artificial intelligence.

