FLUORIDE DOSING FACILITY - WODONGA WTP: DESIGN AND CONSTRUCTION CHALLENGES – SAFETY – OPERATIONS

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ABSTRACT
This paper is an overview of experiences associated with the design, construction, installation and startup of a new fluoride dosing facility at the Wodonga water treatment plant (Huons Hill).

The paper deals with critical aspects of the project including: detailed design, construction, risk to public health, staff training, environmental issues, maintaining treatment plant operations, spill containment and a safe working environment.

KEYWORDS

Haulton, Water, Fluoride, North East Water, Dosing

1.0 INTRODUCTION

North East Water (Wodonga WTP)

The Wodonga population is approximately 28,000 (2001 Census) with 13,712 connections (June 2005). The Wodonga direct filtration WTP at Huons Hill was built in 1989. Fluoride had been dosed on occasions in the past.

Detailed design was completed and compiled by Haulton; with approval sought by NEW in conjunction with the Department of Human Service (DHS). Haulton also employed the expertise of an independent Engineering consultant to ensure compliance.

The entire fluoridation project was designed, managed, constructed and commissioned using all in-house Haulton personnel and infrastructure.

History of fluoridation in the region

Largely to meet the requirements of the nearby Bandiana Army barracks; sodium fluoride was added to the town water supply during the 1980's. However, the supply has not been dosed with fluoride since 1993.

Design overview

The new plant was designed to dose Fluosilicic Acid (20% H_2SiF_6 aqueous solution) and complies with relevant Dangerous Goods Regulations, Australian Standards and legislative requirements.

The design of the fluoridation plant and the layout provides a safe working environment and facilitates safe working practices for the protection of plant operations staff. In addition, complex control measures are included to protect public health and minimise risk of environmental contamination. Critical process control features include: automatic operation with reliable stop/start of the system during plant shut down/start up and operation. Importantly, the risk of overdosing, due to human or system failure is addressed and often backed up by other means of verification.

2.0 FLUORIDE PLANT OVERVIEW

The Fluosilicic Acid system PLC is linked to the plant SCADA control system and master PLC. (The interface from the local control to the master PLC and SCADA system is via Ethernet by NEW)

The Operational features of the system are summarized, in hydraulic sequence, (deliver to dose) below.

- Fluosilicic Acid Unloading bay
  - Fluosilicic Acid is transferred, under supervision by NEW personnel, by the delivery tank driver using an "on-board" chemical transfer pump, hose and three phase power connection
  - is designed in such a way that an accidental spill will be contained within the facility to recapture
  - incorporates a localized sump that is connected to a MARWIL® lockable self closing bund valve

- Fluosilicic Acid Storage Tank (T1) (and Unloading Bay control panel)
  - maximum capacity of tank T1 is 10500L
  - the tank is vented to atmosphere above the roof level of the building
  - the risk of tank "Overfill" is managed by "High-level" signal from a float switch that controls the 415v 3 phase power outlet to the delivery tanker. The power to the unloading pump is also switched off if the tank fill valve is closed
  - a flashing warning light is activated at storage tank high level
  - the tank is fitted with a radar type level transmitter and sight glass for monitoring purposes only
  - the storage room is constructed to allow adequate natural ventilation

- Fluosilicic Acid Day-tank (T2)
  - T2 is refilled automatically on low level mechanical switch, when Transfer Pump (P3) starts pumping Fluosilicic Acid from T1, until normal fill level switch is achieved
  - the tank is mounted on sensitive load cells to monitor content weight as the acid is being dosed and/or transferred
  - T2 weight is also monitored for HL and LLL alarming

- Transfer Pump (P3)
  - is interlocked to switch off and output an alarm in the event High Level (HL) is exceeded, in tank T2, by means of overweight or pump overrun timer
  - in the unlikely event of P3 running on; T2 is overflowed back to the storage tank (T1) via a combined (T1 and T2) venting system; therefore the dosing room is totally sealed from potential acid vapours

- Plant Local Control System
  - is located in the dosing room which is fitted with a door switch activated exhaust fan and external manual override for mechanical ventilation. The control panel is sufficiently spaced away from the dosing equipment
  - the dosing room floor is sloped to a drain that is directed back into the storage tank bund (through a water trap)

- local OFF-AUTO-MAN dosing pump controls. Manual control is via momentary switch to avoid continuous running in error
- the duty pump selection is AUTO-P1-P2. Whilst in Auto mode; duty pump allocation will alternate at the start of each run signal
- local indication of Fluoride residual, plant flow rate, storage tank level, day tank weight and loss in weight/flow-rate calculation (adjusted to display Fl^- component)
- the dosing system is started/stopped by a signal from the WTP and is flow-paced by an analogue signal from the 900 dia Magflo Sensor (supplied and installed by Haulton) located in the treated water pipeline to the 14 ML Clearwater tank. The flow rate signal can be biased via Operator input on CITECT to set the desired dose rate.
- the flowmeter also sends a pulse every 100L for the purposes of the dosing calculations when comparing to loss of weight during that period on T2
- the Fluosilicic Acid dosing system (duty/standby) is designed to provide automatic flow-rate paced dosing
- the duty pump can be selected locally. The pump pacing output signal (ratio control) can be adjusted in the plant room only (via Ethernet)

- Dosing Pumps (P1 and P2)
  - the dosing pumps are equipped with low flow sensing, diaphragm rupture indication, high discharge pressure sensing and an alarm is activated in the event of any of these conditions occurring
  - the pump monitoring incorporates a pump failure alarm, excessive deviation from pump control signal (confirmation by feedback) and T2 LLL.

- Carrier/Sample Water Pump (P4)
  - recirculates water from the sample point to the injection point through the 900 diameter pipework
  - is used to dilute the acid concentration with treated water prior to injecting into the 900 dia pipeline
  - provides pressurized supply of sample water to the online Fluoride analyser located in the WTP laboratory
  - is monitored and will alarm and shut the plant down if either/or, sample/carrier water flow rates are below a pre-determined setpoint

- Fluoride residual monitoring
  - the on-line analyser monitors fluoride levels for REPORTING to the local control system
  - the control system will respond with the following alarms
    - <0.5mg/l for more than 30 minutes causes shutdown
    - >1.0 mg/l – The system shows a warning alarm
    - >1.2 mg/l for longer than 10 seconds the fluoride dosing shuts down and an alarm is raised
    - >1.5 mg/l the fluoride dosing stops immediately, a “High” alarm is raised.
    - also if the fluoride analogue signal is lost (ie: <4mA)
  - the analyser is NOT used to automatically adjust the Fluoride dose
  - the portable Fluoride analyser is used for control verification and remote sample points analysis

3.0 DESIGN CRITERIA

Critical Fluosilicic Acid design criteria, dosing parameters and considerations that influences and/or have a direct bearing on the amount of fluoride dosed, include:-

Control parameters:

- Finished water flow to Clearwater storage (960L/sec = maximum flow)
- Fluosilicic Acid concentration (20% - 25%)
- Fluosilicic Acid SG (1.187)
- Fluoride content of Fluosilicic Acid (188 g/L)
- Desired Fluoride dose as F^- (<1.0 mg/L = maximum safe dose – including background natural levels)
- Pump performance monitoring/verification

Dangerous Goods storage:

- Unloading bay and spill storage; environmental release control
- Bulk storage capacity
- Ventilation
- Security and access visibility
- Compliance with Emergency Services
- Chemical compatibility of equipment

4.0 CHALLENGES

Key challenges were as follows:

- minimizing risk to public health
- minimizing environmental impact
- installation of 900 dia MAGFLO flowmeter (and 750 dia MAGFLO at Wangaratta)
- maintaining water supply and town demand during construction
- adopting a layout that would suit two WTP sites (Wangaratta and Wodonga)
- proving our abilities/capabilities with a new client
- all facets of the project were managed/implemented using "in-house" Haulton personnel
- accurate liquid level monitoring
- ensure adequate mixing of acid prior to sampling
- comply with the appropriate standards to suit site conditions

5.0 SAFETY

Our integrated management system covered our OH&S requirements from a construction point-of-view. We conducted ongoing monitoring and auditing of site records to ensure compliance with our management system and QA accreditation.

Other safety factors considered; were those of operations staff and public health.
In particular, emphasis was placed on minimizing risks from a day-to-day operations point of view. We then implemented the following:-

- minimized the need for staff to enter the storage area and to provide a safe working environment
- maintain minor storage classification for the dosing area
- provide OH&S considerations and PPE
- supply and install "top of the range" equipment and fittings

- triple validation of dosing injection rate and chemical transfer
- monitoring of supporting infrastructure
- security against unlawful/unauthorized entry
- spill containment and control

Figure 1: ***Photo set***

6.0 OPERATIONS

Close consultation with NEW Project Management, Automation and Electrical and Operations teams were maintained during the design and construction phase to encourage satisfactory project delivery. NEW Operations team was invaluable with local site knowledge and assistance.

The main focus on Operational considerations was:-

- Ease of determining and verifying actual dosing rate to minimize overdosing
- Organized Plant layout to avoid confusion
- Labeling and equipment identification
- Pipe configuration (strategic layout and pipe-in-conduit)
- CITECT trending (by NEW), as per below

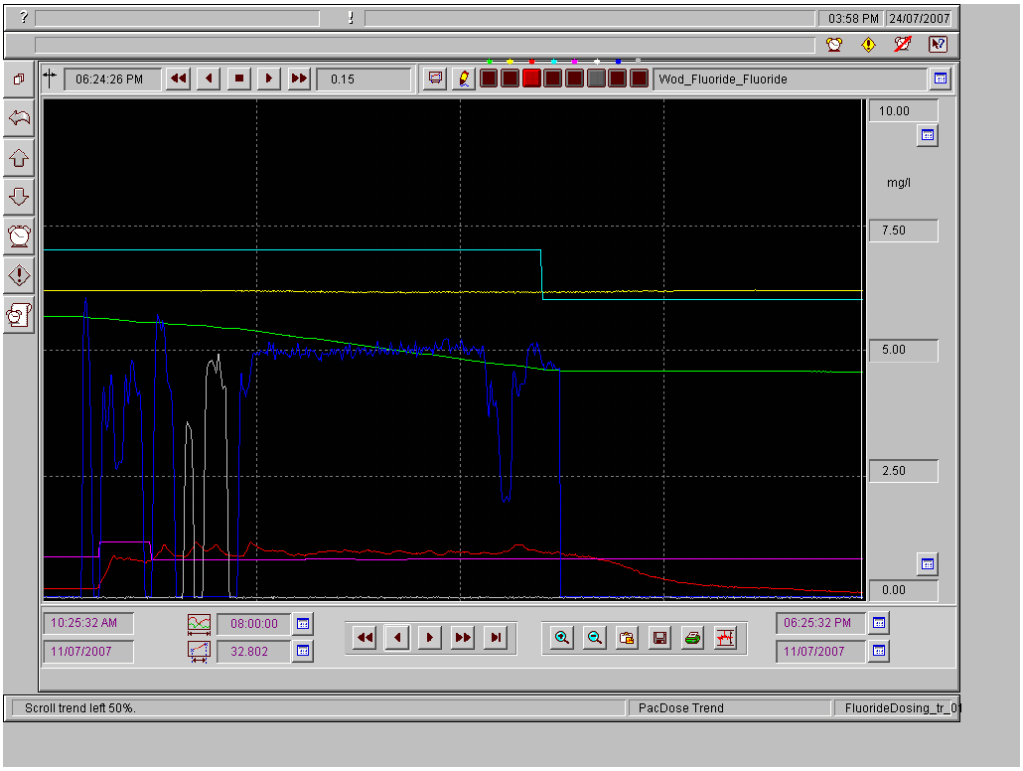

Figure 2: ***CITECT Trending***

PEN LEGEND:-

Green – Day Tank Weight
Yellow – Bulk storage tank level
Red – Fluoride residual
Light Blue – Dose Ratio
Purple – Weight/Flowrate calculation
White – Spare
Blue – Dosing Pump 1 Feedback
Grey – Dosing Pump 2 Feedback

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