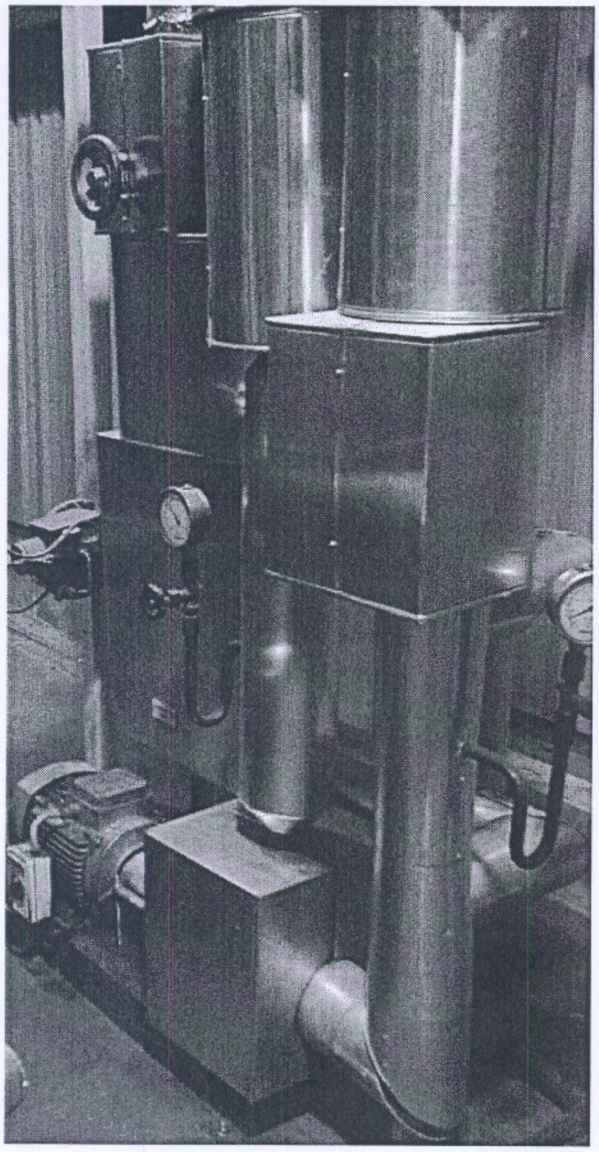
Southern Oil Refineries



Waste Oil Batch Dewatering Plant

Preliminary Design Review

Sept 2006

Rev 0

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SOR03 003 00

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Preliminary Design Review – Batch Dewatering Plant

Summary

MEA was engaged to review the arrangement and equipment of a proposed batch dewatering plant for the Southern Oil Refineries' St Mary's Depot. The system is to consist of two insulated batch holding tanks for waste oil the contents of which are circulated through heat exchangers to raise the waste oil temperature to 90° C. It is intended that the waste oil be heated using surplus thermal oil from the Wagga Refinery.

An analysis of the system has been prepared which models the system performance for heating and oil circulation. The model confirms the heat exchanger supplier's equipment selection and sizing. The model also predicts the pump sizing and flow rates of the circulation pumps.

The heating capacity of the thermal oil heater has also been determined and Consolidated Fire and Steam has submitted budget pricing for a gas or fuel oil fired heater and an electric oil heater. An alternative supplier for a waste oil burner/ hot water heater has also been explored. However we do not recommended that a waste oil burner be used in this application.

System Model

A spread sheet model of the tanks, piping, and heat exchanger was prepared that predicts heat input requirements during heat-up of the oil batch and at steady state during the hold period.

Assumptions and Predicted Output

The following assumptions were used in preparing the model:

1. The waste oil is to be heated to 90° C.
2. The heating medium is to be 110° C maximum with a design temperature drop of 20° C across the heat exchanger.
3. The oil is to be heated over a period of 24 hours and held at temperature for 24 hours.
4. The system will run in batch mode with a cycle of 48 hours, not including empty and filling time.
5. The waste oil is assumed to be SAE30 or equivalent.
6. The holding tanks with be 30,000L each insulated with 50mm of "rock wool" or equivalent.
7. For calculation purposes the model has been simplified to a single heat exchanger and supply pump.
8. The ambient design temperature is 15° C.
9. The waste oil will have a theoretical turnover of 5 times in 24 hours during heat-up; in other words the total flow through the heat exchanger will be 5 x 30,000L in 24 hours.

The model predicts the following:

1. The maximum heat input during the heat up cycle is 50 kW.
2. The heat input during the steady state holding cycle is 6 kW.
3. The waste oil flow rate required will 4 m^3/h.
4. The thermal oil flow rate will be 4.5 m^3/hr.

The circulation rate could be increased without a significant change in heater size, but the resulting pump size increase may make higher flow rates uneconomical.

The large range in heater output through the operating cycle is a significant concern and will likely limit the available heater firing options. This is discussed in the thermal oil heater section below.

Circulation Pump Selection

The design conditions and initial oil viscosity were also used to calculate the circulation pump size. Due to the significant change in waste oil viscosity over the heating cycle, (high viscosity of the oil at the initial ambient conditions and low viscosity at holding temperatures), the circulation pump will most likely require some form of electronic motor management controls or variable frequency drive to limit motor currents at higher oil temperatures. It is unlikely a conventional centrifugal pump will suit this application. A geared pump or progressive cavity pump is more likely to be successful.

The calculated duty for the pump is:

Ambient or "Cold" condition:

- Pressure head of 125m H_2O
- Suction head of -5m H_2O
- Calculated discharge pressure 11 bar
- Calculated motor size 5kW

Holding or "Hot" condition:

- Pressure head of 25m H_2O
- Suction head of -0.3m H_2O
- Calculated discharge pressure 2 bar
- Calculated motor size 0.4 kW

Thermal Oil Heater and Heating Method

The thermal oil heater required by the dewatering system is reasonably small by industrial standards. However the duty range of the heater is quite large requiring a turndown of 10 : 1 which is well beyond the normal range of any single fuel fired appliance. The turndown issue can be addressed in a number of ways:

1. A fuel oil fired appliance two or three burner stages can be used each having a turndown of 4 : 1. This allows the use of conventionally designed burners, but has the disadvantage of increased control complexity and initial capital expense. The arrangement of the burners also necessitates a large combustion chamber which leads to potential inefficiencies.
2. A natural gas fired appliance a dual range burner can be used which has two firing rates. This setup has the advantage of covering both operating modes and has a lower level of control complexity. It also has the advantage of being a well established industrial technology.
3. An electrically heated thermal oil heater with a single variable output element or several switchable elements would provide the range of output required and is also a well established technology.

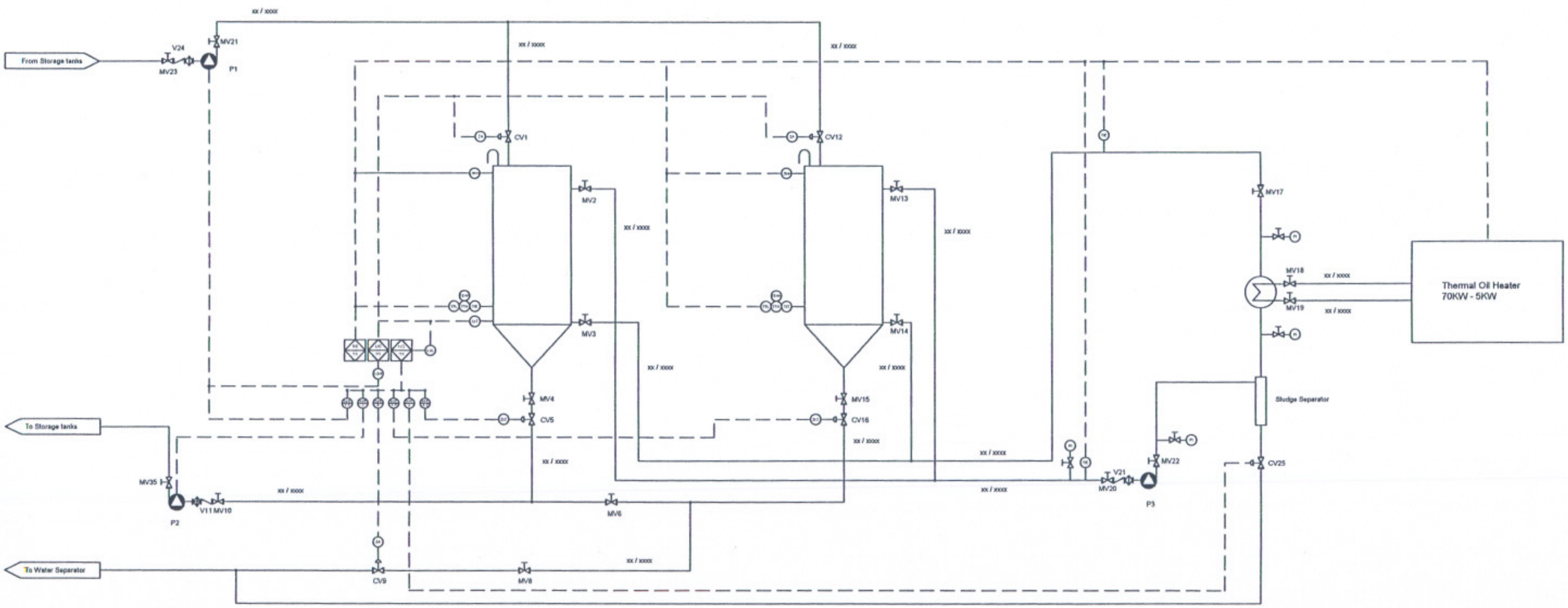
We recommend either the natural gas or electric approach as they are the least complex and have the lower capital cost. Consolidated Fire and Steam has submitted budget pricing for a gas fired heater and an electric oil heater. They have recommended against using waste oil burners in this size of heater. The electric heated unit would be the first design for them, but they are confident in producing that unit or a direct fired burner.

An alternative offered by one supplier, Country Wide Fuel Oil, was a waste oil fired hot water heater manufactured for residential heating in North America. Using hot water would increase the size of the heat exchanger and increase the mass flow rate through the heater on the hot water side. We have requested more information on the system with regard to low output operation. The systems appear to be well built and have a commercial track record in North America, but have no service support in Australia.

Process Control

The attached process and instrumentation drawings SOR03 001 01 and 02 depict the complete system arrangement. One arrangement shows a single heat exchanger the second shows the system with two separate heat exchangers. The level of automation was not discussed in detail during the project brief; the PID shows a fully automated and sequenced system designed to stand alone from other plant and equipment.

The control scheme can be simplified somewhat but given the temperature and level control needs and the sophisticated and inexpensive PLCs available today implementing the sequence control is a matter of a few automatic valves and some programming time. The budget cost estimate assumes this approach.



Notes:

Single Heat Exchanger System Shown

Fully automated batch sequence control system is shown.

Manual system could be used for batch management if required,
however temperature management and level alarming should be automated to reduce operational risks.

Date	Revision	Description	Date
	0	Issue for Approval	4/09/08
	0	Draft Issue	17/08/08

Revision	Description	Date

Drawn: DJKM
Approved:

MEA
MITCHELL ENGINEERING ASSOCIATES PTY LTD

TITLE
Southern Oil Refinery
Waste Oil Batch Dewatering Plant
Process and Instrumentation Diagram

SIZE: A1 | CAGE CODE: | DWG NO: SOR03 001 01 | REV: 0
SCALE: NTS | SHEET: 1 of 1