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Effect of Temperature vs Base Sediment & Water in Waxy Crude Oil

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Introduction

Block RJ-ON-90/1 is located in the state of Rajasthan in North-West India. Four discoveries have been declared commercial within the RJ-ON-90/1 Development Area: Mangala, Aishwariya, Saraswati, and Raageshwari. Bhagyam (and Shakti) are subsequent discoveries and have separate development areas (reference approval from DGH 14th November 2006); the locations of the fields under development naturally fall into 2 geographical groups.

The three largest fields are located in the North of the block and comprise "Rajasthan Northern Area Development": Mangala, Aishwariya and Bhagyam. The significantly smaller fields located in the South of the block comprise the "Rajasthan Southern Area Development", Saraswati and Raageshwari. The size and location of the fields dictates how the fields are to be developed.

It is expected that plateau production rates from Mangala will be achieved shortly after start-up. This forms the core of a wider development and the development of the other Northern fields will take advantage of synergies with the Mangala development. The main power generation plant, oil storage and export point are to be located at the Mangala Process Terminal (MPT).

Figure: 1 Rajasthan Block

The Mangala field crude oil characteristics are as follows:

1. Waxy sweet crude oil
2. Volumetric average gravity of the oil is 27º API; with sulphur content less than 0.2% is estimated.
3. Low gas-oil ratio (GOR) of 82-203 scf/bbl (volume weighted average GOR 184 scf/bbl).
4. The live oil wax appearance temperature is only some 2 to 3oC lower than the average reservoir temperature of 65^{o}C.

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5. Gas contains a high level of carbon dioxide (between 20 and 30mol %)

6. High pour point of (>40oC), which has a great influence on all aspects of the project and the process design to ensure efficient flow assurance.

The field development plan is based on implementation of a water flood from the start of production to maintain reservoir pressure and to sweep reserves.

Hot water, at a temperature above the reservoir wax dissolution temperature, will be injected to ensure that injectivity and efficient oil sweep are maintained.

The following sections provide an overview of the key elements of the Mangala Field Development Plan, with focus on the salient details in flow assurance and production enhancement techniques.

There are a large number of factors that have to be considered in the design of the Mangala facilities.

The main challenges relate to the flow assurance, production chemistry, to maintain optimum temperature which should be above Wax appearing temperature and to break emulsion to meet specification of BS&W. The focus for facilities design for the Mangala Development is to provide flexibility in the facilities design, at optimal cost, to allow for opportunities and uncertainties to be managed during the life of the field.

Theory

Crude from reservoir is mixed with circulating hot water that maintains temperature around 65-70 C slightly above Wax appearing temperature reaches processing terminal for separation of Gas, oil and water.

The production fluid from the Mangala well-pads is received via eight permanent Pig Receivers Skids into a single common inlet manifold and routed to the Slug Catchers.

The Slug Catchers are horizontal, overflow weir-type, three phase separators designed to separate free water, oil and associated gas from production fluids as well as dampening any slugging that may occur from the pipelines. Associated gas flows to the Fuel Gas system (consisting of fuel gas scrubber, fuel gas filters & fuel gas heaters) under pressure control for firing of boilers

The oil/water emulsion stream from slug catcher flows to shell & tube type Production Heaters where the temperature is increased above the emulsion “break point” in order to accelerate oil and water separation in the Production Separators.

The process fluid enters the Production Separators where further oil and water separation and degassing occurs. Each Production Separator is a horizontal, overflow weir-type; three-phase separator which separates associated gas, oil, and produced water. The gas flows to 2nd stage suction of the Vapour Recovery Unit Compressor under pressure control. A spill off pressure control valve to the HP Flare is also provided to accommodate any upset conditions.

The Gun Barrel Setting Tanks are intended for stabilisation of oil and to allow time for gravity separation. The “gun barrel” section of the tank is designed to remove the remaining flash gas prior to entering the “settling tank” section to avoid interference with the oil/water separation in the tanks.

Stabilized oil from the settling tank is pumped by stabilized oil pumps to dehydrator for final stabilization of oil. The Dehydrators are electrostatic Coalescer type units complete with inlet distributors, oil outlet collectors, electrodes and transformers for

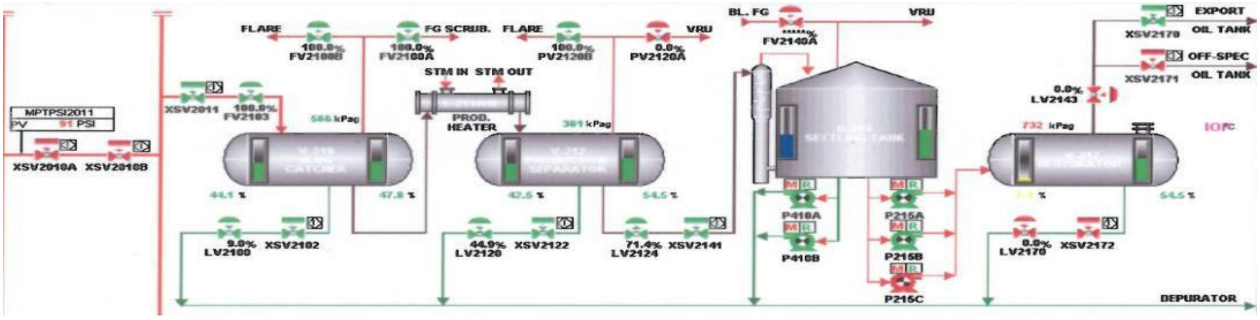

Figure2: Layout of Mangala Processing Terminal

knocking off any final traces of water in the oil, after knocking off final traces of water in dehydrator it is sent to export tanks for export.

Advance Flow assurance and separation technique at MPT.

a) Hot water is mixed with production fluid at surface. The objective is to heat the production fluid temperature by flowing it through annulus of the wells co-mingled with crude at the surface. The circulation water is of high pressure (2600 Psig) and temperature (85 Deg C) which provides motive fluid for the wells equipped with Jet pumps. The system also transfers heat to the production fluids to maintain the temperature above the WAT (Wax appearance temperature).

b) The below Graph mention the temperature profile maintain at processing terminal

c) Production fluid pipelines at Mangala Processing terminal are electrically heat traced to avoid congealing or pressure drop in pipelines due to wax formation.

d) Demulsifer is being injected at Well pads is used to break the emulsion and for proper separation in the separators to meet BS&W as per sales requirement.

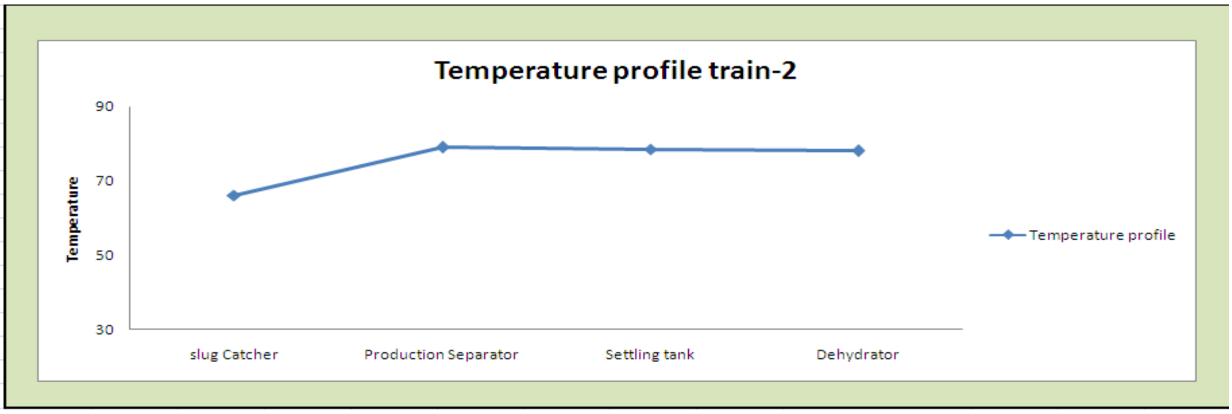

Figure 3: Temperature Profile at Mangala Processing Terminal for train-2

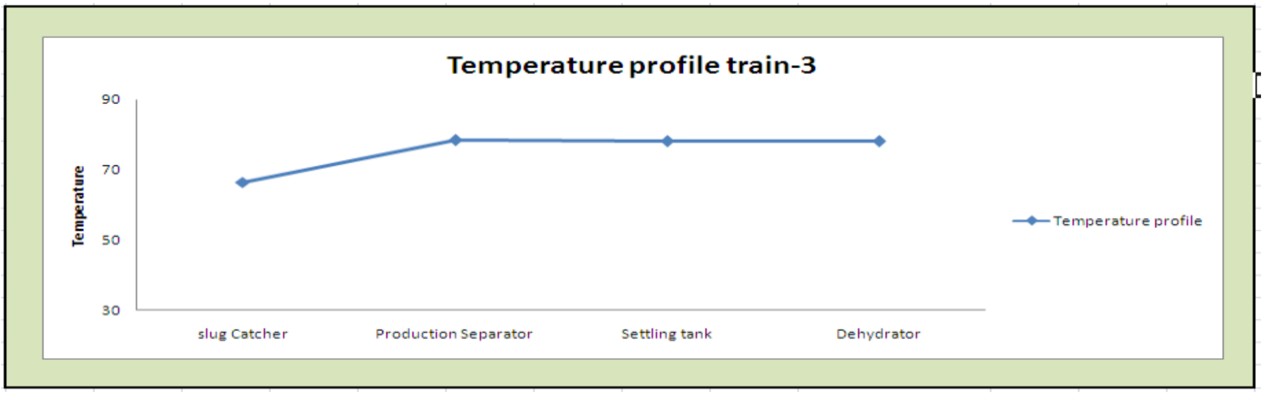

Figure 4: Temperature Profile at Mangala Processing Terminal for train-3

Case Study

Optimizing in operating temperature profile of oil train was carried for better separation of water from oil. Operating temperature profile of oil train is controlled by production heater which utilizes steam for heating the crude oil. Normal operating temperature of production heater is 80 Deg C. When operating temperature of production heater is optimized at 74 Deg C, minimum B.S & W of crude oil achieved is 0.05 % at outlet Settling tank. Conventially emulsion breaking temperature of this crude is 75C. The following figure indicate the drop in temperature profile in the oil train from Production separators to settling Tanks.

Effect of reducing temperature

There were several questions that were raised regarding effect of BSW in crude vis-a-vas lower temperature profile of oil train. This effect can be correlated to the theory of "How temperature affects the H20 solubility in alkanes" which is presented in "Oil and Gas journal". This reveals that at higher temperature solubility of water in crude oil is more pronounced. This is proven during optimization of temperature profile in oil train which is shown below.

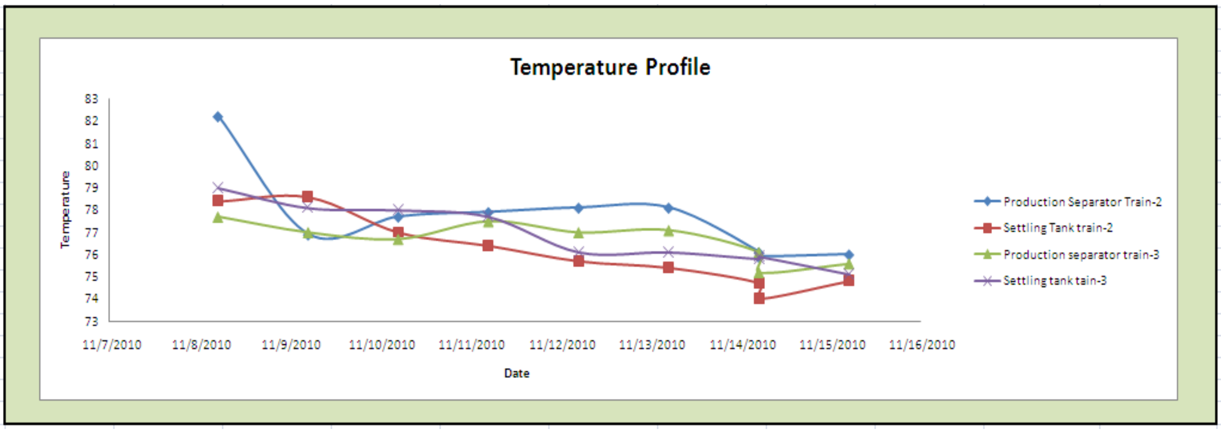

Figure-5: Temperature Profile of production Separator and settling tank during temperature drop from 80C to 74C

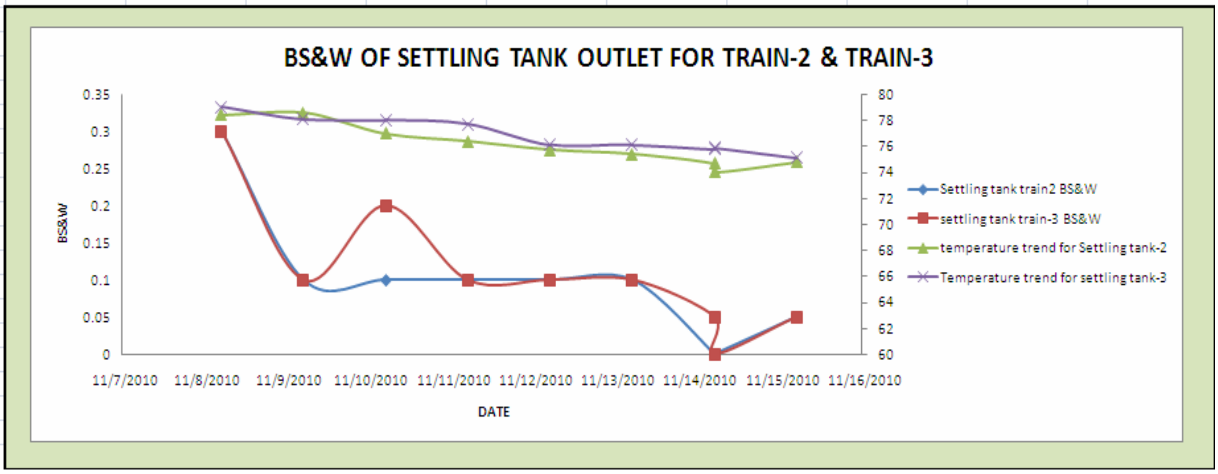

Figure-6: BS&W profile with reducing temperature

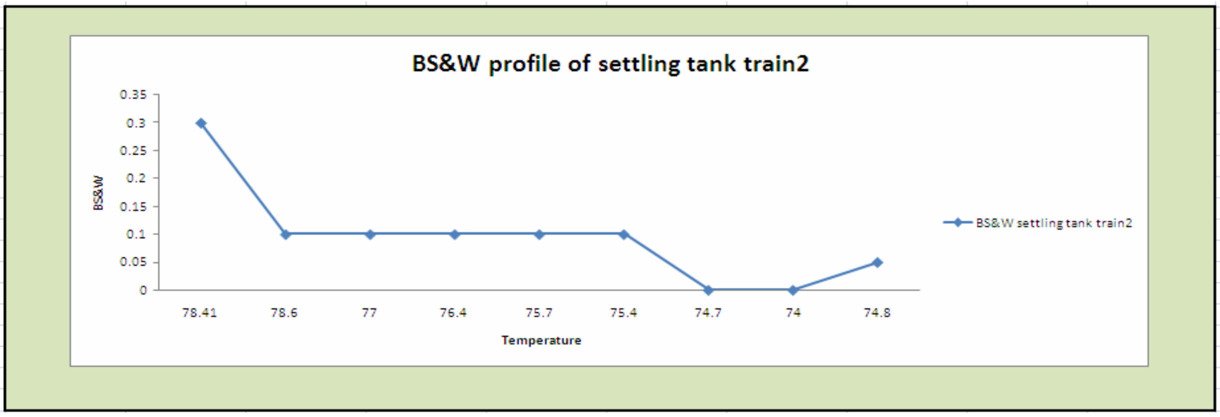

Figure-7: BS&W profile with reducing temperature in settling tank train-2

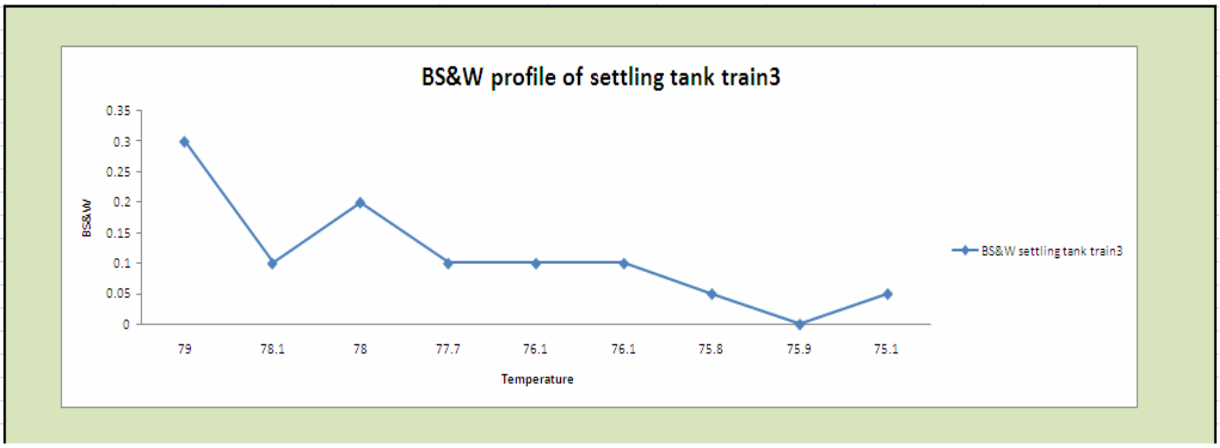

Figure-8: BS&W profile with reducing temperature in settling tank train-3

References

Carl L.Yaws; Preetam M. Rane.: Oil & gas journal How temperature affects water solubility in alkanes.

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