OFFSHORE PIPELINE CHEMICAL CLEANING TECHNOLOGICAL SOLUTION EXECUTED ON AN ARTIFICIAL ISLAND

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Abstract
The purpose of this work is to detail a new method to perform the chemical cleaning of an offshore underground pipeline of 2000 meter length and 8 inches diameter designed to transport diesel, from the jetty area to the container tanks of the offshore artificial Island (Abu Dhabi, UAE). It will discuss how the selection of the proper solvents and technique for a successful cleaning application depends on a number of factors, such as the nature of the deposit, the metals in the pipe to be cleaned, the solvents available, temperatures and safe operating practices.
Keywords: *Pre-commissioning, Commissioning, chemical cleaning, pickling, degreasing, passivation, neutralization, rinsing.*

1. Introduction

Chemical Cleaning is performed in order to remove contaminants that may impair plant operations caused by foaming, poor heat exchange, compressor blades damage and may eventually cause loss of production. For a newly constructed unit or newly installed pipes, it is assumed that they contain remaining oils, preservatives and mill scale left over during construction, so the chemical removal of mill scale and oils and preservatives is frequently necessary. This is especially true in the case of lubricating oil systems and high pressure boilers [2, 4, 13].

The successful and economic application of solvent cleaning depends on a number of factors; such as, the deposits, the metals in the equipment to be cleaned, the solvents available and safe operating practices. The removal of any type of deposit with solvents is a function of the nature of the deposit. The deposits are divided in three big classes; inorganic deposits, organic deposits and mixtures between this kind of deposits [2, 4, 13].

This work was done in one of the offshore artificial islands used as Oil and Gas installations in the United Arab Emirates, in the Persian Gulf. As before mentioned, the core objective of this study is to summarize in a general way, an alternative chemical cleaning technique, that is, to stop using the traditional configuration (loop and closed system) and give way to using a configuration consisting in two pumping stations that resemble a reciprocating method. [2, 4, 13].

2. Operational Challenges

One of the main challenges is that the Diesel-oil line is underground and has a length of almost 2000 meters and 8 inches diameter and there was no parallel line or at least another pipeline that could be used as a return line, and it was difficult to install a return line, because of the length and this temporary return line would have to go through one of the busiest roads by heavy vehicles.

Another challenge was the communication between the two ends of the diesel-oil line (from Jetty area to Storage tanks). The pump and valve operators have been constantly communicating with the field supervisors by means of intrinsically secure communication radio to coordinate the pumping in both sides of the pipe.

It must be taken into account that the process was done in a reciprocating process and this is because the cleaned diesel line was used at same time as the return line; The cleaning mixture was pumping from the jetty area (pumping station 1) to the storage tanks area (pumping station 2). When all the volume of solvents reached the pumping station at the storage tanks, the pumping stopped at the jetty area, after that, the workers configured the valves to return the fluid to the jetty area and vice versa.

3. Safety Challenges

Chemical cleaning is a continuous operation, especially when chemicals are added, therefore the operators were constantly manipulating and setting in the right position all the valves (opening and closing) however, during the summer, in the United Arab Emirates any industrial activity is prohibited from 12:00 to 15:00 because of extreme temperatures. Nevertheless, the chemical cleaning activities are critical and continuous and it is not possible to stop the chemical dosage even with high temperatures, so to guarantee continuous operations

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during the mid-day break and critical activities were assigned extra workers for physically demanding jobs so that people could take breaks as needed.

However, to improve the performance and work continuously even in the stages of rig up and rig down were taken the following actions:

- Adequate shade cover and Increased Ventilation acquired after installing cooling fans at the work site. Short breaks of 20 minutes to cool inside the cooling container to hydrate and reduce body temperature. Rotation of personnel each 40 minutes
- Together with the previous precautionary measures we consider to reduce the Local Exhaust Ventilation at points of heat production or moisture by Reflective Shielding and ventilation increase

The injection point of the chemicals for this job was next to the ocean at the jetty of the island, a windy place where sometimes waves reach the surface; therefore, operators had to wear life jackets.

4. Methodology

The Diesel-Oil Line was chemically cleaned following the steps below [8, 9, 12, 13].

1) System Configuration
2) Water Flushing and Leak Test
3) Alkaline Cleaning (Degreasing)
4) Acid Cleaning (Pickling)
5) Neutralization
6) Passivization
7) Drying

5. System configuration

A) Blinds and valves closed and isolated: a detailed procedure showed blind location and blind list was generated. Valve to be closed or open were clearly Marked-up in the P&ID. all the Non Return valves (check valves) were removed [3, 2, 9, 8]

B) Instruments protected from chemical cleaning: All level gauges and other instrumentation that could be damaged by alkaline or acid solutions were removed or isolated positively. Isolation or disconnection of Instruments and Analyser sample taps to prevent damage was done. [3, 2, 9, 8]

C) Temporary pipes: Location where the chemical cleaning activities were developed was marked-up in a plot plan. A detailed procedure together with the marked-up P&ID was attached. The Temporary pipes and equipment were mentioned in detailed procedure. [3, 2, 9, 8]

The traditional method to carry out a chemical cleaning is through a closed circuit (loop) with continuous recirculation of the solvents. Figure 1 shows a general way of how the equipment is configured for proper recirculation of the solvents, through an injection line and a return line. Figure 2 shows the configuration carried out for the chemical cleaning used to write this assay. [10, 12]

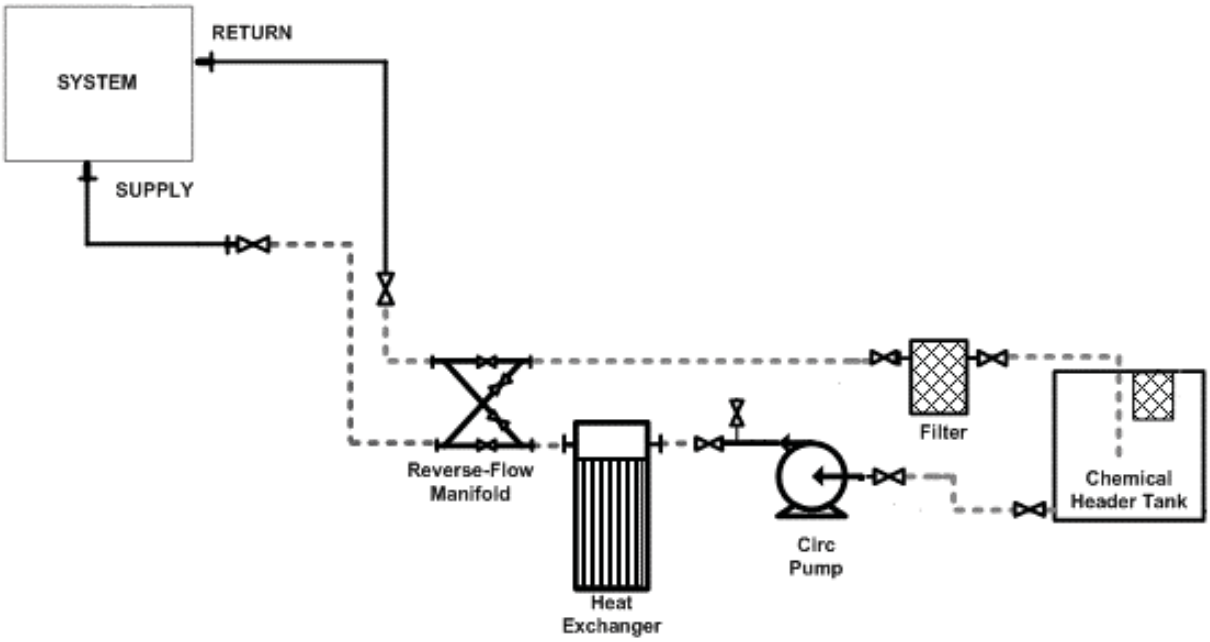

Fig. 1. *Typical System Configuration for Chemical Cleaning activities*

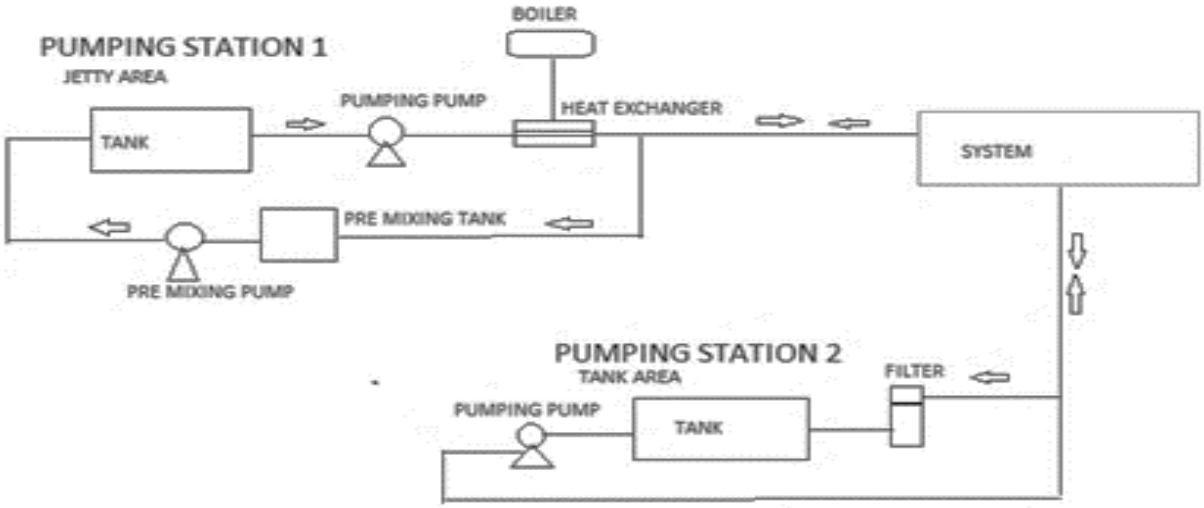

Fig. 2. *System configuration for chemical cleaning by reciprocating method*

6. Water flushing and Leak test

To ensure that no leaks are coming-out from flanges and other connections and prior to the introduction of any chemical into the system, a leak checking using only water was carried out. The system is then filled with potable water and flushed at high velocity at approximately 5 bar (unless required to be less or more by piping design). After the system was filled with water and circulated for approximately 2 cycles a water sample was taken and the clarity of the water was visually verified. Some turbidity is acceptable but the sample must be clear enough to see through it. This step is to ensure the soundness of temporary connections and hoses [4].

7. Alkaline Cleaning (Degreasing)

Degreasing commence by charging the system with clean water. While the water was circulating, it was heated until it reached a temperature between 60°C and 70 °C. Once the water reached the required temperature, Sodium Hydroxide and Surfactant were added into the mixing tank [6, 12]. The solution was circulated at a constant temperature during 8 or 10 hours. During the circulation process, samples of the mixture were taken on an hourly basis and the Alkalinity, pH and temperature were recorded. After three consecutive similar results recorded, the Alkaline Cleaning was stopped and went on to the pickling step [7, 11].

8. Acid Cleaning (Pickling)

Acid inhibitor and citric acid were injected to attain an acid solution. This acid solution was blended with the degreasing chemicals [6, 12] to form a chelant capable of retaining dissolved iron in solution at elevated pH [1, 5]. This acid stage was a pH adjusted, heated from 60°C to 70°C and circulated for 6 or 8 hours. The iron content was monitored to determine the completion of the oxide removal. Other monitored parameters were temperature, pH, iron concentration, and percentage of acid concentration. After recording three consecutive similar results of acid concentration, cleaning was stopped and went on to the neutralization step [2, 9, 12].

9. Neutralization

Neutralization was achieved by adding aqueous ammonia to the acid solution to raise the pH to reach 8.5 or 9.5. Once the pH was reached, the next step was performed [1, 2, 12].

10. Passivization

The solution temperature was reduced to 40°C. Once, the temperature is reached, Sodium Nitrite was added to the mixing tank. The solution was circulated at a constant temperature for 4 hours and pH between 8.5 or 9.5. Upon completion of the cleaning program, the pipeline was drained and the solution was sent to a waste holding tank, and then, the cleaned pipeline was visually inspected and accepted, and then was dried as per the recommended drying method [8, 9, 12].

11. Drying / Prezervation

After the system acceptance, dry air was injected into the pipeline to remove any residual aqueous solution. Once the system was dried, the system was blinded while keeping pressure with Dried Air. The system must be a leak free system and slight positive pressure must be maintained and monitored periodically [2, 13].

12. Acceptance Criteria

A system shall be deemed to be clean and meet the followings conditions [8, 9, 10, 11, 12]:

- Temperature, pH and deposit level of sample solution will be analysed to confirm the cleaning solution efficiency periodically.
- Visual inspection to all the identified inspection point of the system to be checked mainly at 4 points; Chemical Cleaning injection point, Return lines, Inline joint and Fabricated looping spool piping section.

13. Conclusions

With the reciprocating method proposed in this essay the chemical cleaning of a long pipeline section was achieved and were over passed the main problems such as: Return line not available to re-circulate cleaning fluids and Pipeline with high sinuous slopes at the offshore artificial island. The success of the reciprocating method consisted in setting two pumping stations and coordinating multiple crews and equipment, reciprocating chemical batch from end to start points and a dry air high pressure system was used after finalizing chemical cleaning to remove remaining liquids.

By the reciprocating method, the pipeline was 100% cleaned and ready to process hydrocarbon transportations. Optimized cost through reducing chemical volumes (because to fill a return line was not necessary), Optimized operational time by 25% compared with conventional chemical cleaning from competitors (because was not necessary the manufacture and installation of temporary pipes). Without any service quality or HSE incidents during the performance of the chemical cleaning operations.

Nomenclature

P&ID – Piping and Instrumentation Diagram
HSE – Health, Safety and Environment

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