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Tank Farm Modernization - Following the Environmental Requirements

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Abstract

The modernization of a tank farm through the replacement of the current open system of gathering, treatment, measurement and storage in a closed automatic system is dictated by technical-economic reasons regarding the safety of gathering, treatment, measurement and storage, pumping up bi/tri phase separated fluids in the transport system, recovery and minimization of volatile hydrocarbon emissions.

Taking into account the environmental impact of such an investment project from its early planning stages leads to early identification and assessment of potential environmental impacts.

The investment project opportunity of a closed system modernization lies in eliminating potential environmental risks of accidental pollution caused by oil, salt water, emissions of volatile compounds, corrosion of pipelines, of storage tanks, exceeded life cycle of the transport equipment and sometimes human error which may occur in the current gathering, treatment and storage of crude oil.

This article presents the stages of the investment project in compliance with the environmental requirements for an existing petroleum activity. Through specific measures this investment project will significantly minimize the environmental impact.

Key words: *crude oil, organic volatile compounds, demulsifier*

General Presentation of the Current Situation and of the Drafted Situation

The owner of the tank farm and oil treatment plant intends through organizational management to modernize the gathering system, the storage system and the thermo-chemical treatment through a closed system with the possibility of constantly measuring the debit of used fluids, take-over systems, recovery and reinstalling in the technologic circuit of the volatile components.

The open system of gathering and separation, which currently functions in most of the hydrocarbon deposit exploitations from Romania, has the main disadvantage of allowing the loss of a great quantity of volatile elements, that if recovered could lead to their capitalization in the refining and petro-chemistry industry at a more advantageous price than that of crude oil.

Currently, as suggested in Figure 1, at the tank farm crude oil from 14 storage tank farms---modernized storage tank farms[1] (20%impurities), not modernized storage tank farms or oil transported in tank trucks (85%impurities)--- is gathered, treated, stored and delivered to the national pipeline transport operator of oil.According to the tank farm flow diagram, the oil goes through 6 inch pipes to the R4, R6 and R7 tanks. The treatment is done directly in the oil gathering R7, R6 and R4 tanks through steam heating up to 65 - 70°C and DMO[2] injection, the recommended dose being 130 ppm. The injection is done at pump oil absorption. From the tanks the oil is took over by the centrifuge pumps *Cerna – 150* and sent with an impurity under 3% in the R5 or R10 oil tanks. From the R5 and R10 tanks it is also pumped out with Cerna pumps-150 at the transport operator platform, through an 8 inch pipe. The process is discontinuous (works at atmospheric pressure), with hydrocarbon loses in the air, high energy consumption, facilities morally and technically outmoded, without centralized monitoring and guidance of the work parameters. Parts of the disadvantages of an open system are overpowered by a flow in closed system, presented in Figure 2, Process Diagram. The implementation of the new project includes the following: a).connecting the new designed installation to the existing fluid transport pipes; b). blanketing of all tanks, checking and correcting equipment, in order to transform the process into a closed pressurized system; c). treatment and storage are dictated by the daily debits of crude oil, net oil, residual water, but also the maximum pressure of 2 bar, max. temperature of receiving fluids of 10 °C, max. temperature required for treatment of 65°C;d). automation on technologic functions : fluid separation and measurement , thermo-chemical treatment of emulsion, volatile components and tank gas recovery, cleaning and filtering of residual water, oil quality assessment, measurement and treatment of fluids at destination. Crude oil is processed by the national oil pipe transport operator, gases are submitted to the measurement and distribution stations, pre-cleaned water is pumped back to the injection station, then to the injection wells.

Investment Project Description

The technical-economic documentation specific to the whole closed system of gathering, treatment and storage of oil in the central deposit will include the following:
- blanketing in all tanks, with the corresponding checking and equipment, in order to transform the process into a closed pressurized system. A compression module for the recovery and reinstalling of natural gases in the existing circuit is also foreseen.
- all necessary utilities (water, gas, electricity, heat) will be taken from existing tank farm site. The proposed project does not require development of new access roads.

-the proposed project will keep (after pre-scheduled maintenance expertise and timetable) most of the installations and equipment existent in the Central Gathering and Treatment Deposit.
-it will be maintained the current fluid heating system with “pipe to pipe” heat exchanger, necessary to the separation and efficient treatment of the phases from the heterogeneous system.

The heat exchangers use as heating agent the steam from the battery of boilers, situated close to the tank farm enclosure. A *possible* technological approach, recommended, is the replacement of the current system with one that relies on hot water, generated by the installation inside the deposit of an automatic reservoir, with a closed water circuit at the necessary parameters, supplied with natural gases from the existing circuit or newly created through the shutdown of the separation system (blanketing);

[1] A modernized tank farm is based upon the technical concept of skid production, which follows the oil procedure requirements and the standards and safety norms for gathering, sepatation, lebelling and transport of crude oil to the central tank farm and gas gatherer.
Skid production:assembly of mechanical and electrical equipment, automation and pipeline network that deals with gathering, separating and evacuating transported fluids (crude oil and gas).

[2] DMO-Commercial name for the demulsifier TRETOLITE DMO 86400, made by Baker Petrolite

-maintaining the transfusing, heating, gravitational separation possibility of free water in order to prepare it for injection in deep geological structures. The sedimentation open system (through which free water is separated and the oil product is recovered) is designed in the current project to be replaced with a buried tri chambers settler, with the same technical purpose.
-redesigning the existing oil gatherers will impose a specific pattern on extracted fluid quality (modernized storage tank farms- in R7 tank; not modernized storage tank farms-in R2;R6 tanks).
-maintaining the existing pumping systems to ensure the enclosure processes.
-proposals regarding the process improvement.
-construction works- assembly designed to meet the objectives.

The Technological Flow from the closed system implies 3 circuits as suggested in the Process Diagram Annex.

Oil Circuit (represented by the red line)

Crude oil, obtained in not modernized storage tank farms (P2, P3, P9, P11), enters at 2÷5bar pressure in the manifold (diameter: 6 inch), after a pre-measurement with the debit indicators and goes into the oil tank according to TF -10T-101 (R7). From the not modernized storage tank farms (P1, P4, P5, P6, P7, P12, P13, P14) crude oil is directed from the manifold, the measurement system, to the non corresponding oil tank, TF-10T-102 (R2).

Each mixture pipe is designed with safety valve for overpressure (PSV). When the pressure of the crude fluid is overrun (6÷ 10 bar), the corresponding depressurization surplus is taken over by the pipe with the 4 inch diameter and directed to the R2 tank.
From R2, the crude oil is absorbed with the transfer pumps TF10-P-101A/S, lead to heater TF10-H-101, and applied the demulsifier (batcher module TF10-M-101) necessary to the firm separation of the heterogeneous mixture of oil from water. The demulsified oil is transferred in R7 tank.

With the transfer pumps TF10- P-102A/S, the R7 extracted oil is firstly qualitatively checked (in the flow there is a measurement device that indicates water and sediments content); if it corresponds the below 1%impurities value it will go in the TF10-T-103A (R10) or TF10-T-103B(R5) tank with the final destination the national oil pipe transport operator. The content of impurities higher than 1% requires the oil to go through the heater TF10-H -102, through the demulsifiation circuit, through the batcher TF10-M-102 and back to tank R7.

Water circuit (represented by blue color)

Following the gravitational separation of free water from R2 and R7 tanks, it is pulled with the transfer pumps TF10-P-201 A/S and directed to the compartmented water settler TF 100-D-101 designed for the sedimentation and efficient accumulation of the 2 phases: oil and water. From the settler the water is pumped and passed through the heat exchanger TF10-H-103 to also recover the volatile compounds in the gas circuit. After passing the heat exchanger, the water is stored in TF10-T-104 (R9) tank. To sediment and retrieve volatile compounds, the aqueous phase is conducted successively, gravitationally from R9 to R8 and R1 tanks.

From R1 tank, water is extracted with transport pump TF10-P-202A/S, with final destination the injection station.

The oil separated in the settler compartment is extracted with the transfer pump and leaded to the not conform oil tank, R2.

Gas circuit (represented by yellow color)

This circuit has the following sub-circuits:
a). Gas *entry* sub circuit from the network to all the tanks, with the pressure of 0.2 bar---through pressure regulators. This technical option is actually the essential conformation factor imposed through the present project to establish a gas level, pressurized by low pressure over liquid phases in order to keep and recover in a closed system the volatile hydrocarbons, known in specialized literature as blanketing.

b). *Exit* sub circuit of gases from the oil/water tanks. Before being reinstated in the entry line they are passed through the gas recuperation module (made of separator device, gas filter, compressor) destined to volatile fraction clearing.

c). Supplementary evacuation sub circuit of gases from all tanks, in exceptional conditions of passing over the pressure specific to the sub circuit b). are taken over in a safety valve system, passed through the liquid separator and then to the emission basket placed outside the objective.
Regarding the environmental impact, the investment project that aims to modernize the tank farm is structured in 4 stages, as presented below.

Pre-construction stage

It is represented by the following activities:
- Local development planning;
- Obtaining approvals / agreements necessary for the project;
- Detailed design

Construction stage

In this stage are foreseen construction and assembly activities.
a). Expertise activities, maintenance, proper fitting of parts available on site;
b). Activities specific to the implementation of new equipment, destined to the tank farm functioning for the gathering, separation and treatment of the oil in a closed system: manifold, buried settler, gas module, and recovery skid and gas compression.
Both types of activities include (when appropriate) a mix of industry-specific works.
-Land-development project (e.g. implementation of digging, filling, compacting, concrete slabs, performance / maintenance / connecting to the existing system of collecting rainwater drains, dams maintenance, roads maintenance, plant protection, etc.)
- Technological works (e.g. expertise for under pressure vessels, welding control, skid mount and connecting piping systems, installation / isolation valves);
-Plumbing (e.g. thermal network links, links to local sewage system);
-Automation-works (e.g. fitting and adjusting meters, Warning systems, audio / optical)
-Electrical work (e.g. power plant installation, lighting, connections between equipment / facilities).

The works will be performed by mechanized and manual cutting to install new parts and couple links as in the design, technical books, working procedures and the HESQ requirements.
Pressure equipment, fittings, flow meters, transducers, pipes, flanges, alarms, safety valves, etc. will be mounted in place and verified by authorized personnel.
Utilities: water, gas, electricity and other facilities necessary to implement the modernization project are provided by the owner of the existing oil business through existing or additional contracts.

Water regime, industrial water (including intangible reserve IDPs), rainwater and wastewater will meet the requirements of the administrative documents.

The materials as instruments in the construction stage are established without stockpiling sau special facilities for stockpiling. The works designed for this phase are of average duration, and the facilities necessary for the completion of the construction stage are already available in the current tank farm; there will be a contract between the beneficiary, the designer and the contractor.

Functioning stage

The activities from the functioning stage of the new tank farm include:

- Conducting technology trials;
- Circulation of fluids from the tank farms through the new manifold;
- Fluid-metering, dosing the demulsifier, visual operators from electrical equipment, automation, monitored parameters (liquid flow, gas phase, input-output pressure level, etc.), verify the quality of the oil delivered to the national pipeline oil transport operator;
- Scheduled or accidental maintenance for storage, vehicular, measurement equipments, PSI facilities, etc.
- Keep a record of the monitored process parameters;
- Selective gathering, recovery or disposal of waste generated on site;
- Report to the Environment Agency the parameters that need to be monitored as specified by territorial administrative acts;
- compliance of the petroleum business owner with the specific HSEQ procedures.

Of the many environmental aspects recommended by BAT and BREF, the most important concern: energy efficiency, lower consumption (gas, electricity, industrial water), lower emissions of nitrogen oxides, sulfur oxides and emissions of volatile organic compounds, reducing pollution of water sources.

The degree of automation, safety equipment, work procedures and HESQ of the new investment objective necessitate the presence of specialized personnel to ensure safe operation of oil storage and treatment.

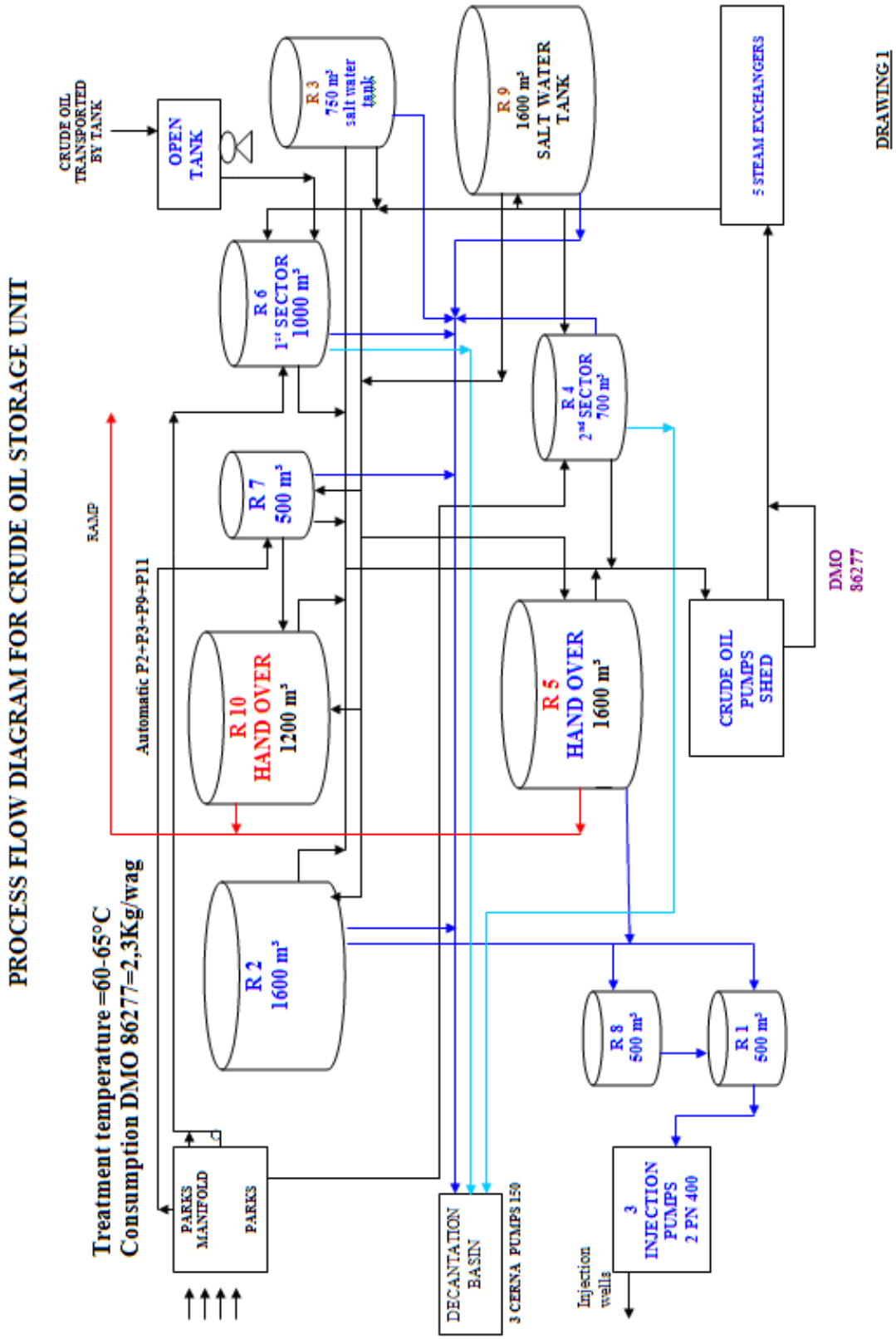
Industrial activity closure stage

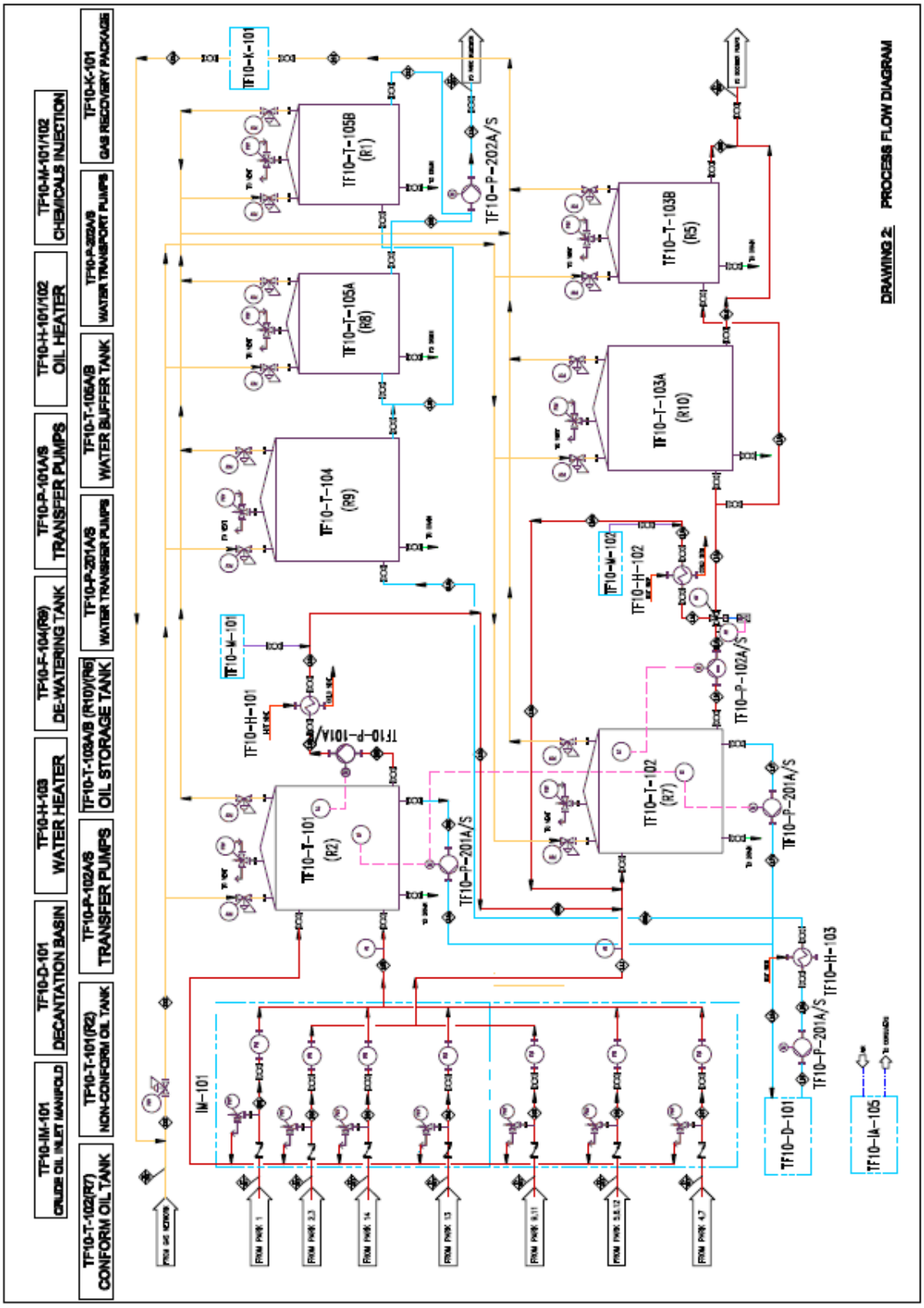
The closure of the tank farm will be dictated by economic and technical reasons related to the life cycle of the full set of petroleum operations involving storage, fluid separation, purification and delivery to the suppliers of useful components.
Closure will be made at the request of the petroleum activity owner, after analysis and acceptance of the application submitted to the territorial authority for environmental protection. The end purpose of this type of work is to restore the land to the original state/ approx. original state; regarding the petroleum business owner, to restore the land to sensitive or less sensitive usage and disconnect from utilities (water, energy, gas).
The decommissioning of the tank farm will be based on technical design and specifications.

Conclusions

The modernization of storage and treatment crude oil deposits must be done accordingly to the measures imposed by the competent environmental authority to the petroleum activity owner.
The HAZOP assessment method, the investment project documentation that substantiates the feasibility of modernization storage tank farms and oil treatment, highlights the superiority of the closed system regarding aspects of environmental protection and safe operation of vehicular installations.

In choosing the best technology related to storage, processing and circulation of oil were taken into account similar experiences in other countries, the financial possibilities of the oil business owner and real-time compliance required by the competent authority.


PROCESS FLOW DIAGRAM FOR CRUDE OIL STORAGE UNIT
Treatment temperature =60-65°C
Consumption DMO 86277=2,3Kg/wag
DRAWING 1
CRUDE OIL TRANSPORTED BY TANK
OPEN TANK
R 3 750 m³ salt water tank
R 9 1600 m³ SALT WATER TANK
5 STEAM EXCHANGERS
R 6 1st SECTOR 1000 m³
R 4 2nd SECTOR 700 m³
R 7 500 m³
RAMP
Automatic P2+P3+P9+P11
R 10 HAND OVER 1200 m³
R 5 HAND OVER 1600 m³
CRUDE OIL PUMPS SHED
DMO 86277
R 2 1600 m³
R 8 500 m³
R 1 500 m³
PARK5 MANIFOLD
PARK5
DECANTATION BASIN
3 CERNA PUMPS 150
3 INJECTION PUMPS 2 PN 400
Injection wells


TF10-IM-101
CRUDE OIL INLET MANIFOLD
TF10-T-102(R7)
CONFORM OIL TANK
TF10-D-101
DECANTATION BASIN
TF10-T-101(R2)
NON-CONFORM OIL TANK
TF10-H-103
WATER HEATER
TF10-P-102A/S
TRANSFER PUMPS
TF10-T-103A/B (R10)/(R5)
OIL STORAGE TANK
TF10-F-104(R9)
DE-WATERING TANK
TF10-P-201A/S
WATER TRANSFER PUMPS
TF10-P-101A/S
TRANSFER PUMPS
TF10-T-105A/B
WATER BUFFER TANK
TF10-H-101/102
OIL HEATER
TF10-P-202A/S
WATER TRANSPORT PUMPS
TF10-M-101/102
CHEMICALS INJECTION
TF10-K-101
GAS RECOVERY PACKAGE
DRAWING 2: PROCESS FLOW DIAGRAM
TF10-T-101 (R2)
TF10-T-102 (R7)
TF10-T-103A (R10)
TF10-T-103B (R5)
TF10-T-104 (R9)
TF10-T-105A (R8)
TF10-T-105B (R1)
TF10-H-101
TF10-H-102
TF10-H-103
TF10-P-101A/S
TF10-P-102A/S
TF10-P-201A/S
TF10-P-202A/S
TF10-K-101
TF10-D-101
TF10-IA-105
IM-101

References

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3. *** GD. 445/2009 establishing the framework procedure for environmental impact assessment.
4. *** www.aval.co.uk: Guide to Gas Tank Blanketing
5. *** Regulation (EC). 1272/2008 of the European Parliament and the Council on classification, labeling and packaging of substances and mixtures.

Modernizarea depozitelor de ţiţei – conformare cu cerinţele de mediu

Rezumat

Modernizarea unui depozit de ţiţei (tank farm), prin înlocuirea actualului sistem deschis de colectare, tratare, măsurare şi stocare, într-un sistem automatizat, închis este dictată de motive tehnico-economice privind siguranţă colectării, măsurării, tratării, depozitării, pompării fluidelor separate bi/trifazic în sistemul de transport, recuperarea şi minimizarea emisiilor de hidrocarburi volatile.

Luarea în considerare a efectelor asupra mediului ale unui astfel de proiect investiţional încă din primele etape ale planificării acestuia, conduce la identificarea şi evaluarea din timp a unui potenţial impact asupra mediului.

Oportunitatea proiectului investiţional, de modernizare în sistem închis, pentru titularul de activitate petrolieră, rezidă din eliminarea potenţialelor riscuri de mediu induse de poluări accidentale cu ţiţei, apă sărată, emisii de compuşi volatili, coroziuni ale conductelor de amestec, rezervoarelor de stocare, echipamentelor de vehiculare cu ciclu de viaţă depăşit, uneori erori umane care pot avea loc în actualul depozit de colectare şi tratare a ţiţeiului.

Prezentul articol, prezintă etapele proiectului investiţional care se raportează la exigenţele de mediu pentru o activitate petrolieră existentă, dar, care prin măsurile proiectate va conduce la o minimizare semnificativă asupra elementelor de mediu.