Part-1: Mothballing (Asset Preservation) of a Crude Oil Gathering Center

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ABSTRACT
Kuwait Oil Company (KOC) produces Crude Oil from various fields and adjusts the production rates in order to meet OPEC's quota.
Due to expected weak Crude Oil demand worldwide following the global economic crisis in 2008, KOC is considering equipment Preservation by Mothballing one or more GGs in S&EK assets in such a way that the GC would be readily available to be put back in operation when required.
The success or failure of mothballing the facilities depends on a number of factors such as:

- Shutdown duration, preparation and removing all process materials.
- Responsibility allocation for proper implementation of the Mothballing Procedure.
- Materials and equipment used during the preservation.
- Maintaining & recording the preservation conditions during the idle period.
- Personnel expertise in mothballing materials proper implementation.
- Safety programs and active routine audits..

Keywords: KOC, Asset Preservation, Mothballing Procedure, Oil & Gas Facilities.

1. INTRODUCTION

KOC produces crude oil from various fields in Kuwait which are divided into three different Assets as follows:

- North Kuwait (NK)
- West Kuwait (WK)
- South & East Kuwait (S&EK).

In order to meet the market demand internally and also adhere to OPEC's crude production quota, crude oil production from NK and WK is normally kept at maximum rates allowable from each Oil Producing Well, while production from Wells feeding the fourteen GCs in S&EK varies since S&EK is considered as the Swing Producer adjusting production upwards or downwards, as needed.

S&EK is dominated by the Greater Burgan Fields. Wells effluents are directed via dedicated flow lines, and then commingled into a number of dedicated headers prior to feeding the fourteen Gathering Centers (GCs) for phases' separation and crude oil treatment to the required specification.

The treated crude oil to specification from each GC is pumped by a Booster pump then by a Main Oil Line pump via a dedicated transit pipeline to the Export Oil Tank Farms.

Due to decreasing oil demand worldwide following the global economic crisis in 2008, and in order to avoid operating one or more GCs at reduced capacity (inefficient operation), or shutting down GC(s) with no preservation for an extended period of time, KOC is considering mothballing of one or more GGs in S&EK assets in such a way that the mothballed GC(s) would be readily available to be put back in operation when required. Mothballing helps in preserving facilities without reduction in useful operating life and keeps them in "ready for start-up" conditions.

A Taskforce Team (TFT) comprising specialists from various groups within KOC was formed in September 2010 for the purpose of defining the following:

- The steps necessary for identifying the GC(s) to be mothballed.
- The Capacity to be mothballed.
- The duration of mothballing.
- The Mothballing Procedures to be implemented.
- Lessons learned from other organizations related to mothballing.

There are different mothballing procedures for various facilities preservation periods since the preservation procedures differ for periods up to 18 months and for periods exceeding 18 months up to five years.

Equipment and piping in a process industry are subjected to faster deterioration during periods of idleness. Carbon steel equipment can suffer general and/or pitting type corrosion due to the presence of moisture, oxygen, stagnant pockets of corrosive process fluids, deposits of scale, etc.

The objective of mothballing is to ensure that the equipment including piping and fittings are preserved in good conditions such that it will not be deteriorate due to internal and external corrosion and that the GC(s) would be readily available for commissioning and start-up within a short period (weeks) of de-mothballing.

This write up covers Part-1 of Mothballing related to the steps we have taken and our approach for the practical and successful implementation of mothballing procedure incorporating lessons learned from previous application of similar procedures, and what do we really need to safeguard our assets from deterioration during the idle time.
Part-2 shall be presented sometime in year 2012/2013 after the GC is put back in operations and shall cover our statistical analysis of our findings during the mothballing idle period, lessons learned including implications of our findings for any problem identified, and our conclusion.

2. BRIEF DESCRIPTION

2.1. Definition

Mothballing is the preservation of production facilities for a specified period of time and kept in good working order in idle conditions without production so that when needed, the facilities can be put back in production within a short period of de-mothballing.

2.2. Mothballing Objectives

- To preserve equipment without any considerable loss of useful operating life and without excessive costs.
- To maintain the preservation status with a minimum of maintenance activities.
- To be able to activate and re-commission the equipment / plant at a minimum cost and delay.

2.3. Mothballing Strategy

The Mothballing Taskforce Team (TFT) has studied the three alternative Mothballing Execution Routes as shown below.

- In house
- Consultant
- Turnkey

The execution of Mothballing and subsequent monitoring and inspection depends on the strategy Route selected. In all cases, HSE shall be the paramount factor.

2.4. Mothballing Duration

The preservation process (different corrosion control method and procedures), and the associated costs are influenced by the idle period duration in addition to risk insurance company requirements.
In general, the idle period duration may be classified into three periods as shown below:.

- 1 month to 2 years.
- Between 2-5 years
- More than 5 years.

For storage tanks the short term is 6 to 12 months.

2.5. Mothballing Procedures

In order to preserve the facilities for an extended period of time successfully and without being deteriorated mainly due to corrosion, it is imperative that the necessary approved preservation procedures are adhered to without any deviation. These procedures are divided into three categories:

- Internally (KOC) developed procedures.
- Equipment's Vendors' Procedures.
- Third Party (Consultants/Contractors) Procedures.
- Internationally Accredited Procedures.

2.6. Identification Process for selection a GC.

The TFT members have discussed a number of criteria that deemed to be relevant and lead to identifying the GC(s) that could be mothballed and excluding other GC(s) from Mothballing. These criteria included the topics listed below. Section 3.6 below shows the flowcharts for identifying a GC for mothballing.

3. DETAILED DESCRIPTION

A global decline in crude oil demand is anticipated and that would make it difficult to sustain the current level of production. Cut in production quotas are expected. Anticipating future outlook for oil demand, it would be prudent to develop and embark on a strategy that is best result oriented with regard to the production capacity utilization of KOC facilities.

When a large production cut-back is required for a prolonged period of time, the current operating practice is to shut down an entire GC(s) without mothballing. or operating a number of GC(s) at reduced capacities. This practice is detrimental to plan and equipment integrity mainly due to corrosion attack such as:

- Internal corrosion
- Pitting corrosion
- Galvanic Corrosion
- Microbiological Corrosion

Internationally acceptable practice for a prolonged production shutdown is to mothball and preserve the facilities by employing suitable preservation method depending on the shutdown duration.

KOC has no the experience regarding mothballing practice and therefore, the management has decided to set up a specific Taskforce Team responsible for:

- Establishing the necessary mothballing procedures.
- Evaluating the available mothballing technologies.
- Short listing the execution strategies.
- Identify the GC(s) to be mothballed.

3.1. TFT Members:

The TFT comprised Core Members and Supporting Members.

Core Members:

- Production Operation (Process)
- Inspection and Corrosion (I&C)
- Maintenance, Support and Reliability (M&SR)
- Operational Technical Services (OTS)

The two Authors mentioned above were also part of the Core members. The TFT team was led by Team Leader Production Operations (EK-I).

Supporting members:

- Field Development (FD)
- Health, Safety, & Environment (HSE)
- Standards
- Planning

3.2. Typical Equipment in a GC

The fourteen GCs are not all identical in terms of equipment's size, number and type but typically, each GC has the following systems:

- Main Plant comprising 2-phase & 3-phase separators and knock-out drums.
- Desalting and Dehydration Trains
- Condensate Recovery Unit including Tank Vapour Compression.
- Effluent Water Treatment.
- Crude Oil & Effluent Water Tanks
- Crude Oil Booster and Main Oil Line Pumps.
- Utilities and Offsite facilities including Flares.
- Piping, fittings, and Controls.
- Main Control Room.

3.3. Available Technology

The preservation materials listed below are identified for external & internal protection:

- Inert gases such as Nitrogen and dry air.
- Proprietary Vapour Corrosion Inhibitors (VCIs)
- Desiccants
- Solvents and Emulsions
- Hydrocarbons such as diesel, kerosene and treated light crude oil.
- Greases and Oils
- Coatings (paints, varnishes
- Wrapping and insulation.

The selection of the appropriate preservative is influenced by the following considerations:

- Climatic Conditions
- Material of Construction and product handled
- Duration of preservation
- Disadvantages, e.g. flammable, sensitive to air, etc.
- Cost of mothballing vs. cost of equipment
- Available/Approved budget.
- Re-commissioning duration after period of idleness.

3.4. Mothballing Procedures

KOC developed in-house preservation procedures covering stationary mechanical equipment, pipelines, and rotating equipment. The preparation of these procedures was based on international standards and published literature and also on vendors' guidelines. Two alternative periods are considered in the internal procedures developed by KOC relevant to 1-18 months and long term 19-60 months' preservation periods. These procedures also cover re-commissioning (pre-commissioning) procedure.

3.5. Mothballing Strategy (KOC)

The alternative strategies (options) addressed by the TFT for mothballing execution are shown below. The major area of concern irrespective of the selected option is the duration taken for the preparation and final approval of the Contract documents within KOC.

A. Option: In-house

This option leads to KOC personnel full involvement, responsibility, and accountability to the high management.

Although this option could be implemented in shorter time and cheaper than the other two options B & C shown below, there is an element of risk, as this is the first time such activities are undertaken by KOC. On the other hand, KOC will gain direct experience in mothballing application.

The execution of work shall be through an existing maintenance contract under KOC supervision.

- In-house development and approval of the necessary mothballing procedures.
- Quantifying all equipment and components such as instruments, electrical & mechanical equipment, tanks, vessels, piping, junction boxes, enclosures, cabinets, panels, flanges, hinges, etc.
- Developing detailed scope of work including de-mothballing and commissioning.
- Identifying and selecting the applicable preservation materials for the various equipment

and components in the GCs based on the specified mothballing duration.

- Estimating the quantities of the preservation material necessary.
- Prequalify, select, and Supervise suitable local contractors for job execution.

B. Option: Consultant

KOC prepare Consultant's Scope of Work, identifies an experienced Consultancy Company responsible for the activities listed below:

The appointed Consultancy would be experienced in the mothballing field, risk is averted and KOC involvement shall be minimum and limited to coordination with the Consultancy Company.

- Preparation of Mothballing Scope of Work.
- Mothballing Procedures shall either be KOC in-house developed, Contractors' procedures or internationally accredited procedures.
- Screening and identifying suitable Contractors for the supply and application of suitable mothballing materials.
- Supervising the mothballing execution and monitoring including equipment inspections during the mothballing period.

C. Option: Turnkey

This option is identical to Option "A" above but with less KOC involvement in the tasks' execution and the accountability is shifted to the Main Contractor..

KOC prepares the Scope of Work, identify and select an experienced Single-Accountability Contractor who would be responsible for:

- Selecting, supply and application of all the necessary preservative materials and tools in accordance with approved procedures (KOC or external).
- Supply the necessary supervisory personnel.
- Monitoring and inspection of the mothballed equipment during the mothballing period.

KOC shall provide the necessary labours working under the Contractor's direct supervision.

The flowchart in section 3.10 below shows the Options related to the Mothballing studies considered by the TFT members.

3.6. Identification Process for selecting a GC:

The flowcharts in section 3.10 below show the five steps briefly described below that KOC TFT considered necessary for identifying the GC(s) than can be mothballed.

Step 1: Facility HSE Concerns covering:
- Gas Flaring issues
- Effluent Disposal issues

Step 2: External Factors/Directives covering:
- GC's location in Strategic Area
- Bordering Inhibited Area
- Other Strategic Factors

- **Step 3:** Reservoir Management covering:
  - GCs with ongoing Projects
  - Wells with ESP feeding GCs
  - Dry/Wet/Critical Wells production

- **Step 4:** Operational Factors covering:
  - Equipment Constraints
  - Underutilization Capacity
  - OPEX/BBL
  - Reallocation of resources
  - Ease of rerouting production to another GC.

- **Step 5:** Cost Estimate shall be based on:
  - Duration of Mothballing
  - Mothballing Strategy (Option)
  - Scope of Work

In addition to the mothballing cost and its associated monitoring/maintenance cost, the cost estimate shall also take into account the restart cost to achieve full production.

3.7. Visit to ADMA-OPCO

In December 2010, selected TFT members visited ADMA-OPCO offices in Abu Dhabi for the purpose of finding out the mothballing executing process and lessons learned.

The purpose of the visit was to gain experience from ADMA on how did they manage to maintain the equipment idle for such a long period (about 25 years) without deterioration and negative impact on equipment's integrity.

Apparently, a number of equipment has been replaced due to production enhancement reasons and not due to deterioration.

Summary of ADMA's mothballing activities:

- Utilized in-house generated procedures.
- Dedicated TFT followed-up Contractor's activities.
- Subcontracted the Mothballing activities to a third party.
- Nitrogen at 15 psig was used for equipment blanketing.
- Rotating equipment mothballing was as per vendors' procedures, e.g. Pumps have been removed mechanical seals and impellers flashed-off and kept under nitrogen pressure.
- Motors: Wrapped in plastic.
- All vessels' internals have been removed.
- All valves (except PSV's) and instrumentations have been removed, tagged, and stored in a warehouse.
- Small bore piping: filled with inhibited water.
- Pipelines: filled with treated crude.

- ADMA has carried out Lab tests and found that an alternative media, Vaporized Chemical Inhibitors (VCI), is very effective in preserving equipment and has recently applied VCI on a leg in a Platform

Based on the visit to ADMA-OPCO, VCI preservation media seems to be an attractive choice to be considered.

3.8. Visit to ARAMCO

A team visited ARAMCO in May 2011 and toured Gas/Oil Separation Plant (GOSP), which was mothballed since November 2010 but it can be ready for re-commissioning within a two weeks.

ARAMCO employed Consultants to define the Criteria for selecting a GOSP for mothballing and to produce the mothballing procedure.

Preservation:

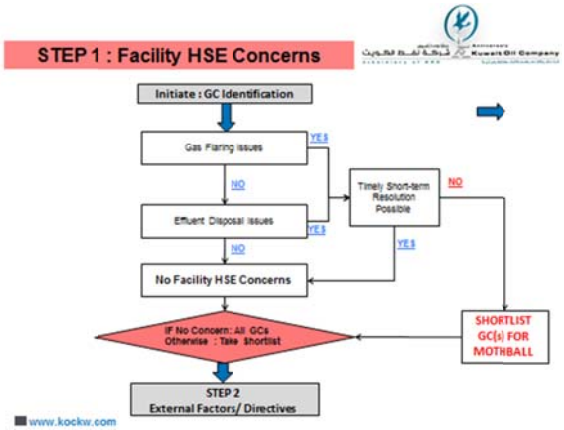
- Nitrogen was used for mothballing all stationary mechanical equipment and piping.
- Diesel oil for the rotating equipment.
- The shafts were stored vertically in a warehouse without any preservation in and without air conditioning.
- The crude transit pipelines were kept full of dry crude oil (^{o}API about 36).
- Power was kept on to provide electricity for the site and for air conditioning.

3.9. Recommended Mothballing Steps

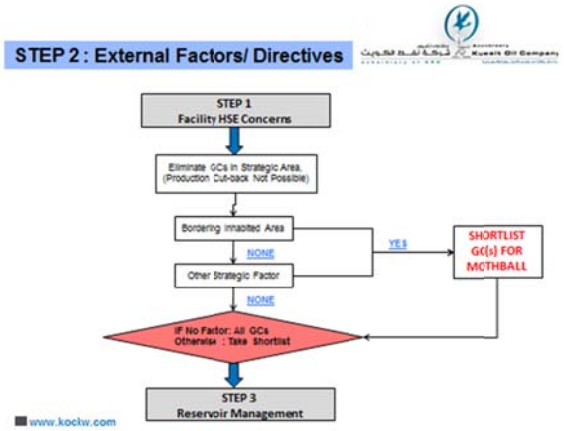
- The plan shall clearly state the length of the intended preservation time span and the required re-commissioning period.
- Plan for adequate funding and manpower are provided throughout the life of the mothball process to maintain preservation effectiveness and equipment readiness.
- For an effective and successful mothballing, the following steps are recommended:
  a. Establish a Task Force Team comprising personnel from various relevant disciplines.
  b. Identify facilities to be mothballed and re-commissioning concerns.
  c. Identify Options and Alternatives.
  d. Decide on the mothballing procedures (internally developed or otherwise).
  e. Identify the execution methodology (internally managed or contracted out).
  f. Establish Mothballing cost including routine Inspection and Maintenance cost during the idle period.
  g. Establish cost benefits.
  h. Seek Management approval to proceed.

3.10. Figures

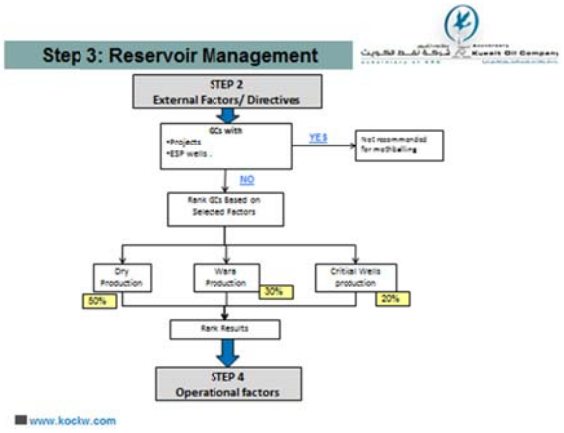
Mothballing Strategy (Options)



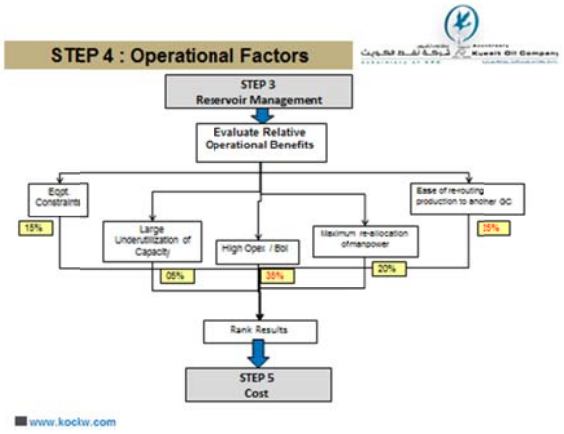
Step 1: Facility HSE Concerns



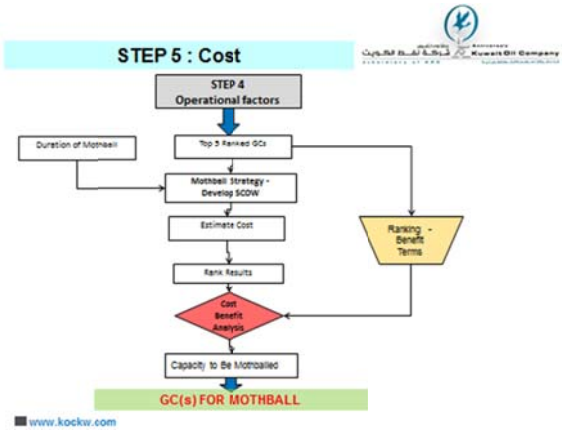
Step 2: External Factors/Directives.



Step 3: Reservoir Management



Step 4: Operational Factors



Step 5: Cost

3.11. Lessons Learned from KOC visits

- Irrespective of the idle period, severe corrosion can occur under some circumstances, e.g. ammonium or amine chloride deposits on equipment can be very corrosive if equipment is opened to atmosphere.
- For successful equipment's preservation during idle time, a well-developed mothballing Plan should be executed in a timely fashion and closely monitored.

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Dr. Al-Otaibi has over 17 years' experience in the process plant design and engineering for onshore facilities Gas, Oil, Water Treatment and Injection. He has a vast exposure over commissioning & start-up of crude oil and Gas gathering centers. His knowledge to the Mothballing practices in the Gulf region has put him on heading Kuwait Oil Company's Mothballing Standards Team. He has been in the circle of middle management for over 10 years exposed to executive decisions and participating effectively in many strategic visions that helped shaping the Oil Sector future plans. He is still acting Manager Operations in East Kuwait fields.

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