



مجموعة كانو

The Kanoo Group

POWER & INDUSTRIAL PROJECTS DIVISION

Innovation Case Study

“CORROSION PROTECTION SOLUTION FOR LARGE CRUDE OIL STORAGE TANKS”

[JUNE 2009 – 2011 (CURRENT)]

Kanoo P&IP – Corrosion SBU Team

1. About the Organization

- **Kanoo P&IP Division's Vision :**
“to be the ***Natural Choice*** of Customers by evolving as a leading Company in the region offering ***Technical Solutions*** through ***Innovations*** and ***Collaborations***”.
- **Products and Services**
 - Safety products, services & Training
 - Supply and Refurbishment of Machine Tools
 - Consultancy for layout and Tools & Equipment
 - Maintenance, Repair and Operations,
 - Chemicals Supply and HSE related audit
 - Corrosion Inhibitors Supply & turnkey projects
 - Equipment and services to power & desalination plants

Customer's Problem

- To pursue our vision, Kanoo P&IP engineers regularly visit industrial customers and ask them, “What engineering problems do you face?”

“Tank full” of Problems

- During such visits to oil storage facilities, the customers mentioned problems relating to maintenance of oil storage tanks:
 - New tanks require hydro-testing by filling them with water
 - Large quantity of fresh water required (1 million barrels per tank)
 - Water is treated with toxic corrosion prevention chemicals
 - After testing, water is discharged in sea adversely affecting marine life.
 - Existing tanks maintenance
 - Corrosion underneath bottom plate of oil storage tanks
 - Bottom plates have to be replaced frequently
 - Huge cost of replacement
 - Tank out of use for long periods
 - No solutions available for real time condition monitoring of bottom plants
 - Monitoring of leakage of product through the floating roof seals and quantification of leakage
 - Manual de-sludging of tanks which a dangerous operation
 - Difficult to monitor level of crude inside tanks

Data Collection

- There are 1,200 large size Crude storage tanks in the UAE and this number is growing by 10-15% per year.
- Approximately US\$ 100 million is spent by oil companies on maintenance of such tanks annually.
- The following solutions were currently in use:

- The existing solutions & problems with them
 - Prevention of corrosion due to hydro testing :
 - Fresh water mixed with biocides and oxygen scavengers is used leading to unnecessary wastage of a precious resource and damage to marine environment due to discharge of the contaminated water after testing.
 - Bottom plate corrosion
 - Bottom plate condition monitoring only upon emptying the tank – **Tank outages and therefore regular reduction in storage capacity**
 - Replacement of corroded bottom plate incurring tank outages and high costs.
 - Cathodic corrosion protection for underneath of bottom plate – **Ineffective on tank periphery leading to environmental pollution due to regular leakages from bottom plates**
 - Knowing level of oil in a tank
 - Visual level and leak monitoring involving human interference – **Inaccurate and dangerous**
 - Tank De-sludging
 - Human entry and manual process – **Highly unsafe to humans, tank outage**

People Involvement

- A team was formed consisting of engineers as below:
 - Kanoo P&IP, KSA – 4 engineers
 - Kanoo P&IP, UAE – 3 engineers
- Project Sponsor - GM-P&IP
- The team was allocate budget of US\$ 30,000/- for visiting customer sites and pilot programs aimed at satisfying the customers with proposed solutions and obtaining product approvals.

Search for Solution

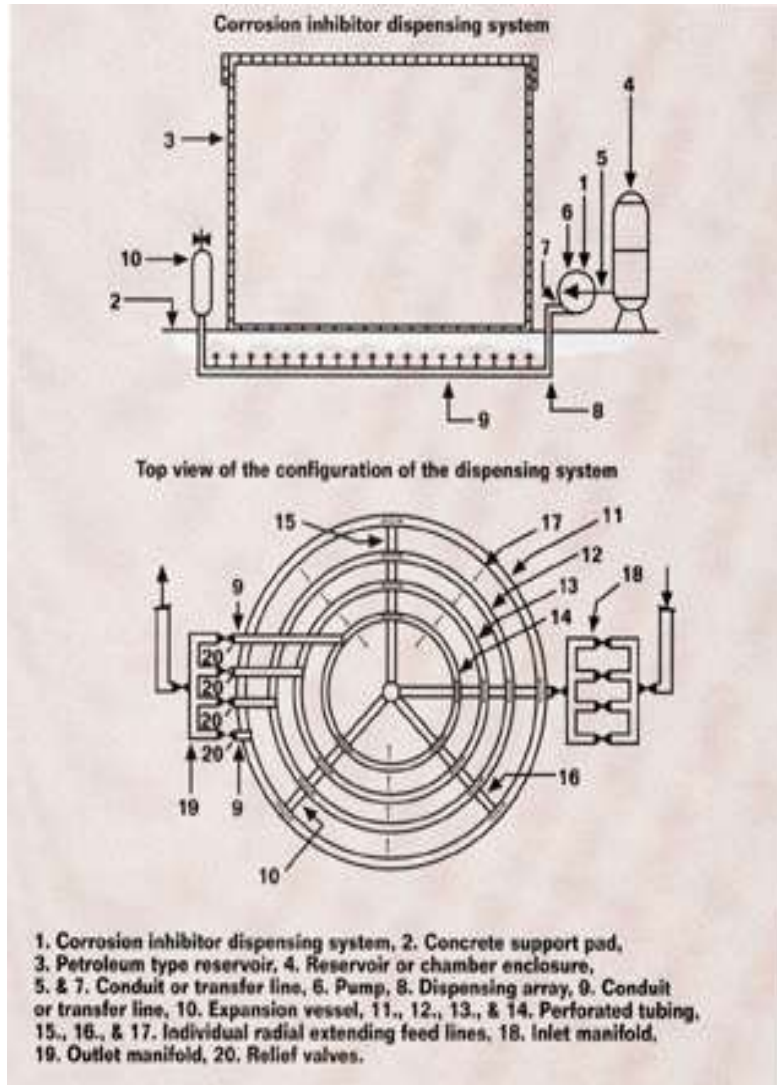
- Kanoo P&IP has strategic partnership with Cortec, USA.
- Cortec had already carried out corrosion prevention projects on double bottom tanks in the USA but lacked experience in Single Bottom tanks which are prevalent in the Middle East region.
- Kanoo P&IP has partnership with Flir Systems, Sweden to market Infra-red thermal cameras, which are used for remotely measuring temperature in electric power equipment and industrial processes.
- In order to exploit the opportunity more effectively, Kanoo P&IP decided to come up with a comprehensive tank solutions to address all tank related problems faced by customers.
- In addition a number of new partners for other tank solutions were added

Search for Solution

- Kanoo P&IP engineers studied Cortec products and developed concepts for the solutions of the problems faced by the customers.
- Cortec carried out detail engineering.
- Kanoo P&IP engineers worked with the customers to :
 - Explain them the proposed solutions,
 - Obtain their buy in for conducting trials
 - Persuade them to plan budget for the trials
- The concepts are explained in the following slides:

TANK BOTTOM PLATE – CORROSION PROTECTION SYSTEM

FOR EXISTING & NEW TANKS (10 YEAR LIFE ENHANCEMENT)



New Tanks & Replacement Floors

- Vapour Corrosion Inhibitor (VpCI) powder is evenly spread under the bottom plate.
- Application dosage: 5 to 10kg per 100 sq m
- Option to spread powder during plate repair /change

Existing Tanks

- Corrosion detectors are fixed under the bottom plate.
- Circular perforated piping is inserted under the tank bottom
- Slurry of VpCI powder with water is injected via several ports on the circumference to prevent corrosion and resulting leakage of crude oil from the tank.

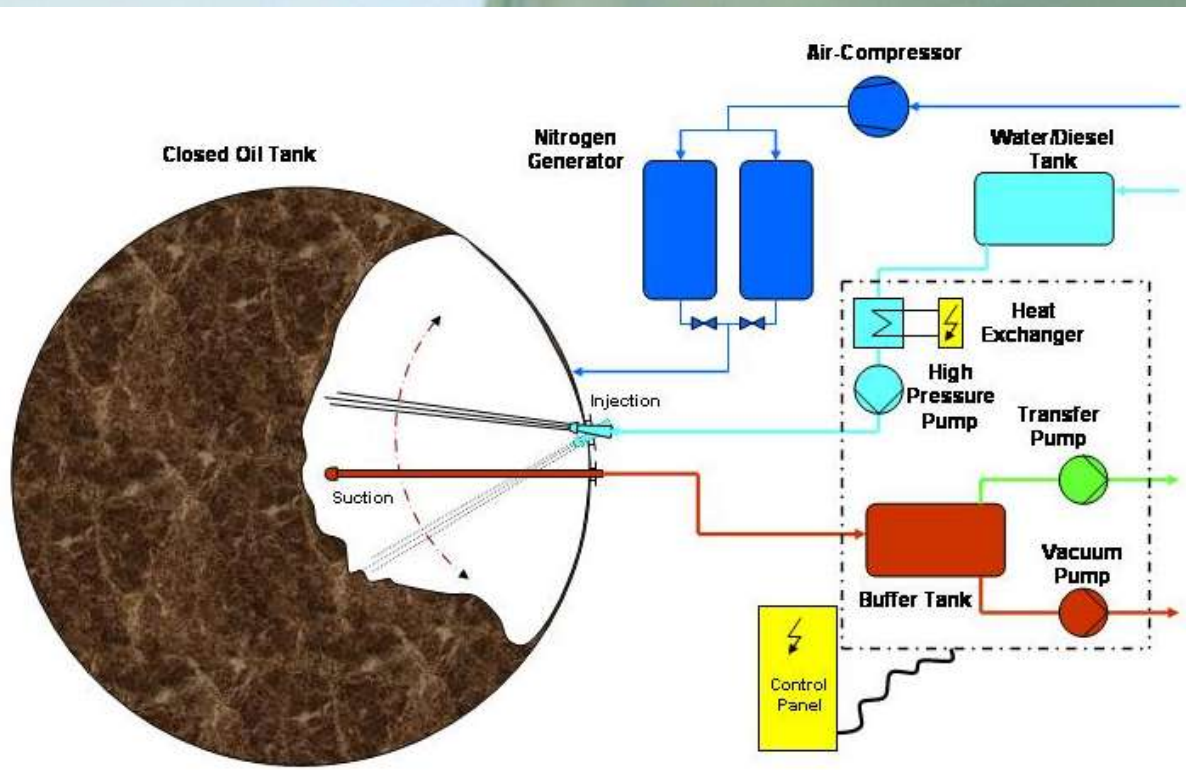
Tank Cleaning Process

- Existing Process:
 - Tank is emptied.
 - Workers enter the tank wearing gum boots and gas masks.
 - Workers manually remove sludge using shovels and load it in buckets.
 - Sludge is disposed off in land fill (no recovery of crude)
 - It takes months cleaning the average size tank & is a major safety hazard for workers involved.

TANK CLEANING SYSTEM WITHOUT HUMAN ENTRY

Proposed Process:

- The tank is filled with Nitrogen to create an inert atmosphere in it.
- A movable nozzle is inserted in the tank through port holes near the tank's bottom.
- Hot water @ 80 Degrees C is pumped in at a high pressure (6,000 psi) and the nozzle is moved from side to side.
- Hot water dislodges sludge.
- Water and sludge mixed is sucked out by a vacuum pump into a buffer tank
- From the buffer tank, the mixture is transferred to a treatment unit, which recovers crude oil.
- Water is reclaimed and reused in the washing process.



Advantages:

- No human entry in the tank; Process control from outside
- Modular unit with one control panel.
- Re-circulation of the wash water
- High purity of recovered crude oil
- No pollution due to disposal of oil
- ATEX approved system

- Cortec already had a product for corrosion inhibition in ballast tanks of ships
 - Ballast tanks are filled with sea water
 - Chemical is dosed in the tank which floats on water surface
 - As the tank is drained the floating chemical cover the tank's vertical wall with a protective coating.
 - The chemical used is biodegradable and environmentally friendly.
- The team brainstormed and using the Principle # 13 “The Other Way Round” of 40 Inventive Principles of TRIZ, the team suggested that the corrosion inhibitor should be added when tank is being filled with water, thus coating the walls as the water level rises.

HYDRO-TESTING WATER ADDITIVES



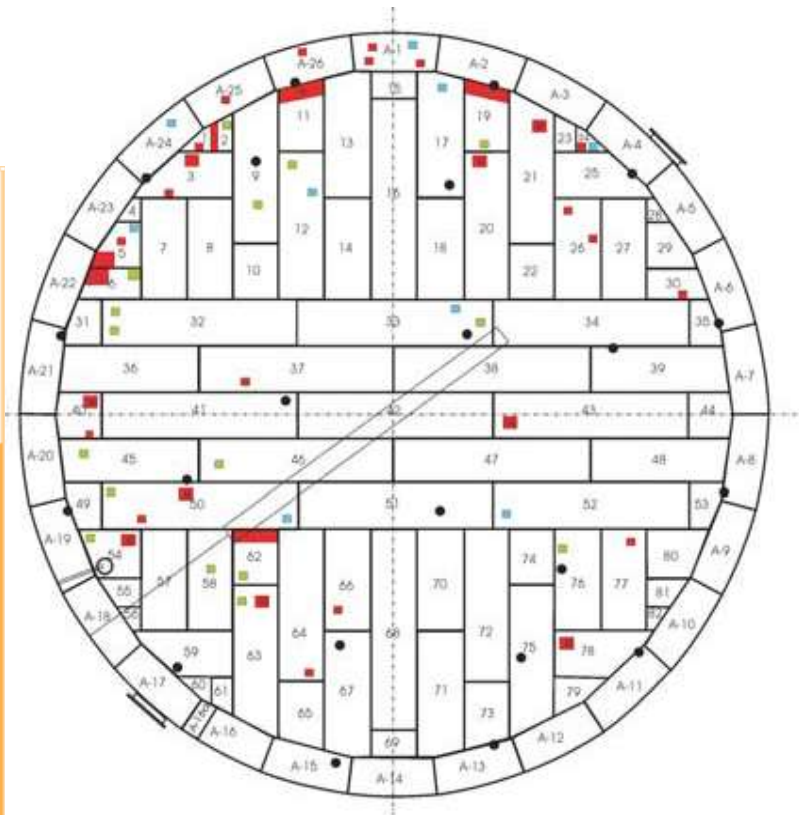
- Kanoo P&IP innovated & with Cortec USA developed special hydro testing additives containing biodegradable oxygen scavengers and corrosion inhibitors.
- The hydro testing additives developed help use sea water instead of fresh water.
- The additives provide short/medium/long term protection from corrosion post hydro testing.
- Sea disposal approvals obtained from EPA, EAD etc....

TANK FLOOR / ROOF PLATE SCANNING

Low Frequency Electromagnetic Technique (LFET)

FEATURES

- A remote controlled NDT unit is lowered into the tanks to reach its floor to measure its thickness thus avoiding human entry. Thickness data is shown on a remote LCD panel.
- Carried out once the tank has been cleaned. High speed NDT scanning
- 32 / 16 channels -- Falcon Sr./ Jr.
- Real time data display with advanced signal processing
- One man operated system
- No couplant required
- Wheel assemblies provide easy maneuverability
- LEDs with adjustable threshold provide a visual alarm
- Falcon Jr. specially designed for hard to reach areas.



INSPECTION SUMMARY

DENOTES	
	0% to 20% Loss
	20% to 40% Loss
	40% to 60% Loss
	60% & Above Loss
	Hole
	Support

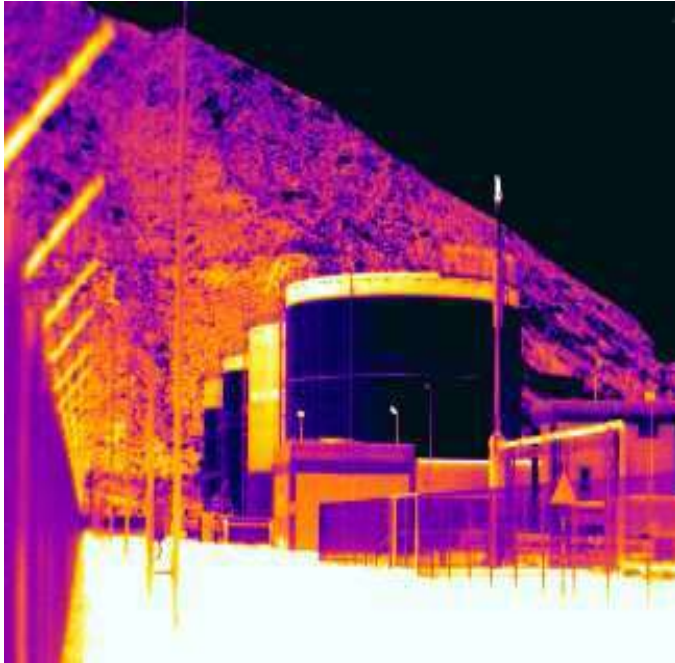


REAL TIME TANK FLOOR INSPECTION



- No need to empty or clean the tank.
- 100% tank floor inspection while in operation.
- Verified reliability.
- Inspection and evaluation of annular ring.
- Immediate results.
- Rapid testing: 50 meter tank in one-day.
- Identification of tanks that need inspection and repair.
- Leaves good tanks on-line and save the shut-down and cleaning costs.

DETECTING TANK LEVELS & LEAKS USING “FLIR INFRA RED CAMERA’S”



- The team proposed use of Flir thermal imaging camera for detecting tank levels
- Level of crude in a tank can be easily determined from a distance, without going to the tank farm. It saves labor, time and exposure of human beings to the risk (Sun, vapor) & provides a more accurate assessment
- The Flir camera is also used for detecting gas/vapor leaks from seals of tank floating roof
- Flir IR cameras are marketed and serviced by Kanoo PIP & is already an established brand in the market

4. Process

- The concepts developed by Kanoo Engineers were discussed with the Principals (Cortec, Flir & Others) and their acceptance on feasibility was obtained.
- Joint presentations to the customers were made by Kanoo P&IP and Principals' technical experts.
- Major seminar on some of the critical problems in tanks viz. bottom corrosion protection was held at Saudi Aramco, Dammam (attended by 135 engineers of Saudi Aramco)
- Customers' buy-in was obtained for trials.
- After working for one and a half year, finally during July, 2011 first order for USD 200,000/- for bottom protection of one single bottom tank was received from Saudi Aramco during July'11.
- In addition Flir systems have been applied on pilot schemes in ADNOC Group companies.
- This is the first of its kind project in the Region and gives Kanoo P&IP entry into the massive tank maintenance market available.

Risk Assessment & Trial

- Major risk involved with corrosion protection of existing tank bottoms was drilling underneath a tank full with crude oil.
- A number of joint strategy sessions were held along with Aramco HSE, Operations and Cortec/Kanoo teams to assess and plan to mitigate all risks involved.
- Aramco developed laser guided hydraulic drilling systems underneath the tank within a 250 mm gap and running deep at least 25 meters at times.

4. Process (contd.)

- Product trials were carried out by Cortec at their USA facilities using similar soil samples as in M.E region
- Based on satisfactory results on above, Aramco went in for full scale implementation.
- Implementation involved HSE planning to ensure safety during drilling underneath the existing crude oil tanks.
- Risk Assessment & mitigation sessions involved Kanoo/Cortec, Aramco and third party experts to draw out a complete list of risks. These were then informed to all parties to ensure preparedness at all stages of project execution.
- Corrosion monitoring is crucial to assess the effectiveness of the solution. Various drilling points were made primarily for corrosion monitors. These will be monitored on monthly on six monthly basis to assess and evidence the effectiveness of the solution implemented.

5. Results

- There are 2,100 tanks in KSA and 1,200 in the UAE with about 10% growth per annum.
- The spend by oil companies in UAE alone for maintenance of tanks is on an average US \$20 M p.a. Overall market size in the region is estimated as US \$100M p.a.
- Kanoo P&IP can potentially capture a major share of the market potential as there is no competition to the comprehensive solutions developed by Kanoo P&IP with its principals.

5. Results

- Figures (actual / projected)
 - Sales - Planned vs. Actual:
 - * 2011 (Planned \$200K, Actual \$200K confirmed orders)
 - * 2012 (Planned \$1,000K),
 - * 2013 (Planned \$4,000K)
 - Market share:
 - >5% (2011),
 - >7% (2012)
 - Customer Satisfaction: High, as these are critical problem areas for clients
- Other intangible benefits: Using the tank bottom opportunity, Kanoo P&IP can develop a comprehensive package of tank related problems faced by the customers. This opens up a complete new business front for growth .
- The solutions developed by Kanoo P&IP so far
 - Can potentially save US\$ 20 million annually for its customers
 - Reduce risk to human health and safety
 - Reduce environmental pollution.

6. Learning

- Tank configuration underneath bottom plate which is uniform in Europe and USA, varies dramatically in M.E region. There are no fixed designs e.g. some tanks have GRP layers under bottom plate but a few have no retainers.
- In addition number of existing tanks have no corrosion monitoring systems in place which is quite standard in the West.
- Such design variations were not envisaged during the conceptualization stage.
- Based on this learning, we have decided to carry out mapping of a majority (at least 60%) of tanks or other systems before designing any engineering solution in future.

7. The Way Forward

- Team members involved in the project implementation were recognized by Kanoo management and this success was highlighted in the company newsletters of Kanoo and its principals.
- Cortec and Kanoo engineers prepared white papers on the tank bottom protection and tank hydrotesting using sea water further fine tuned based on the learning.
- Cortec is currently undertaking further lab trials for future product development to improve effectiveness on varied tank designs available in M.E. Kanoo P&IP Engineers are playing active role in these trials.
- Kanoo P&IP is keeping all potential clients abreast of the project implemented for Saudi Aramco and other technical developments been undertaken by Cortec.
- Additionally, a few other tank related solutions either have been already applied or are under pilot test with major clients in the region.



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Q & A

Thank You