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INTERNAL AUTOMATED MODULAR WASHING SYSTEM FOR TANKERS AND RAILCARS

KMT INTERNATIONAL INC. presents complete stationary modular internal washing systems for tankers and railroad cars after caring petroleum products.
System performs high quality clean up of trucks and rail tanks. Washing solution is recycled for multiple usages.
System versatility is secured by its ability to clean tanks used for transportation of different oil products with any residual product quantities.
Compliance with safety requirements is achieved by using mostly hydraulic system, instead of electric motors, as well as excluding personnel presence during washing cycle inside the tank.
Washing solution recycling dramatically reduces waste water discharge.
The process was designed after many years of research and development. System utilizes closed washing cycle, which excludes personnel contact with tanks internals, increasing safety and efficiency of system operation.

1. System performance

Our washing system is able to wash 30-40 single railroad cars (60 metric tons capacity) per day used for heating oil (heavy oil) transportation and corresponding quantity of tanker cars depending on their size.
System can also be used to wash railroad car tanks and tanker cars used for diesel or gasoline transportation. In this case throughput will be doubled.
System operator selects pre-programmed washing program determined by transported product.
Tanks used for heating oil (heavy oil) transportation are washed in three cycles; using cutter stock then following washing with caustic solution and finally rinsing with hot water.
Tanks used for gasoline or diesel fuel transportation are washed in two cycles using caustic solution and rinsed with hot water.

2. Tankers and railcars washing process description

Single unit is capable to wash two tanks placed on adjacent parallel tracks at a time: (while two tanks placed along each side of washing station on rail tracks are washed, the other two tanks are prepared). Length of washing cycle is selected by operator.
Washing cycle gasoline and diesel cars:

- Wash for 15-20 minutes using water and caustic (pH 12-14) at 65°C.
- Rinse for 15-20 minutes using water at 65°C.
- Allow car to air-dry and cool before closing and sealing manway.

Washing cycle heating oil (heavy oil) cars:

- Tank pre heating (if required) by steam before washing.
- Wash for 45-60 minutes using cutter stock) at 65°C.
- Wash for 15-20 minutes using water and caustic (pH 12-14) at 65°C.
- Rinse for 15-20 minutes using water at 65°C.
- Allow car to air-dry and cool before closing and sealing manway.

During washing cycle residual oil product is recovered and rail car is prepared for product change or repair. Our equipment excludes personnel presence inside car during washing cycle. Car conditions and amount of residual products is inspected by operator before choosing washing cycle.

Any significant amount of residual product is pumped to special storage tank provided by Customer. Product recovered and regenerated during washing cycle also stored in a special storage tank. Car inspection allows operator determine required washing time as well as washing cycle settings.
After car is set for washing, top manway is opened and special manway adapter with telescopic washing apparatus is installed (See Photo #1-4, Photo #6 and Pic. 1), hoses are connected and the washing cycle started. Telescopic washing apparatus is equipped with orbital washing heads (See Photo #5 and Pic. 2). During prewashing inspection, operator selects washing and rinsing solutions type and then solutions are pumped to appropriate tanks. In case car was used for heating oil transportation and is being prepared for product change, cutter stock will be used as washing solution. Caustic solution will be used for rinsing and hot water for final stage.

3. Washing process with telescopic apparatus

Photo #1-2. Extending telescopic apparatus.

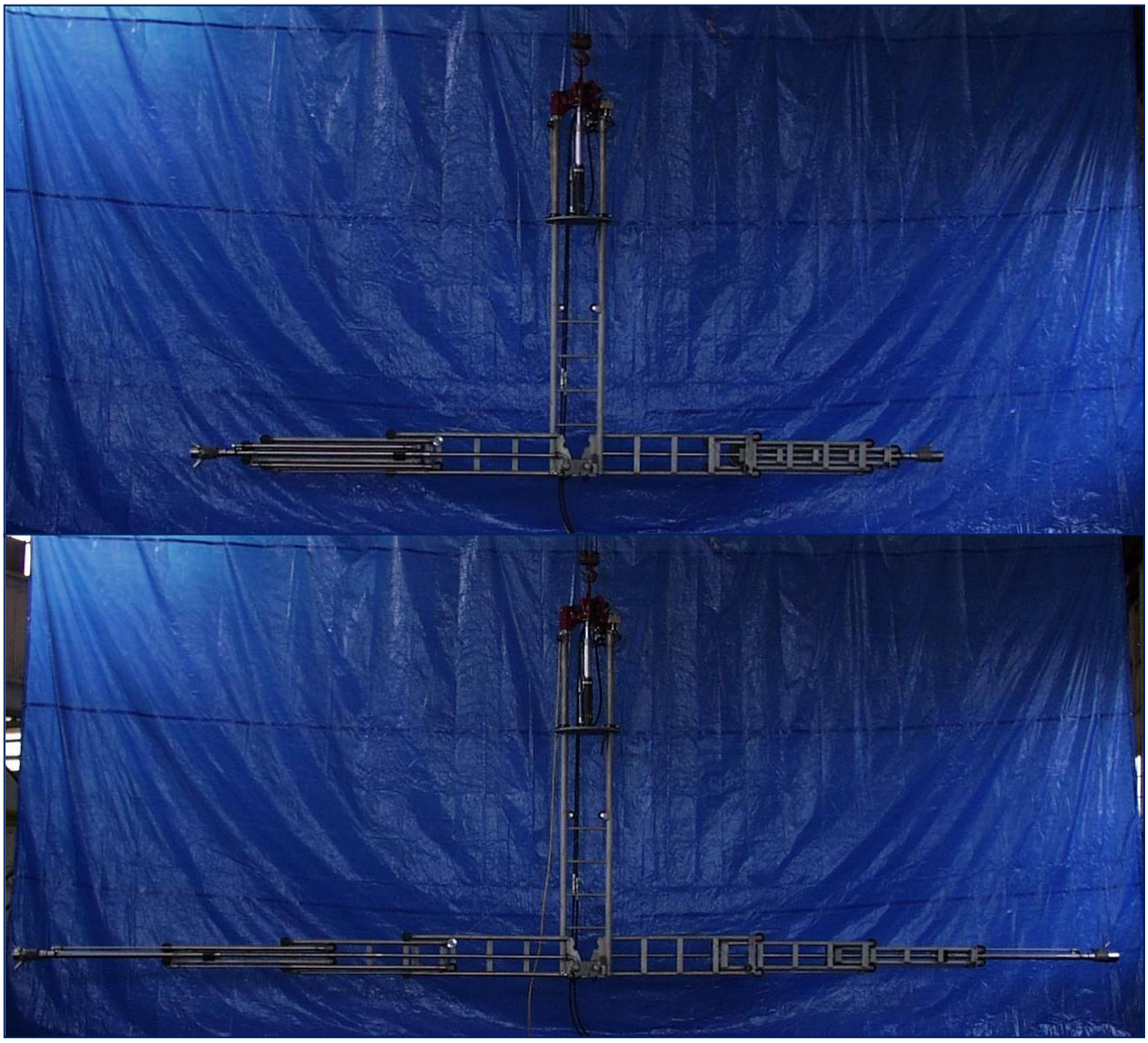
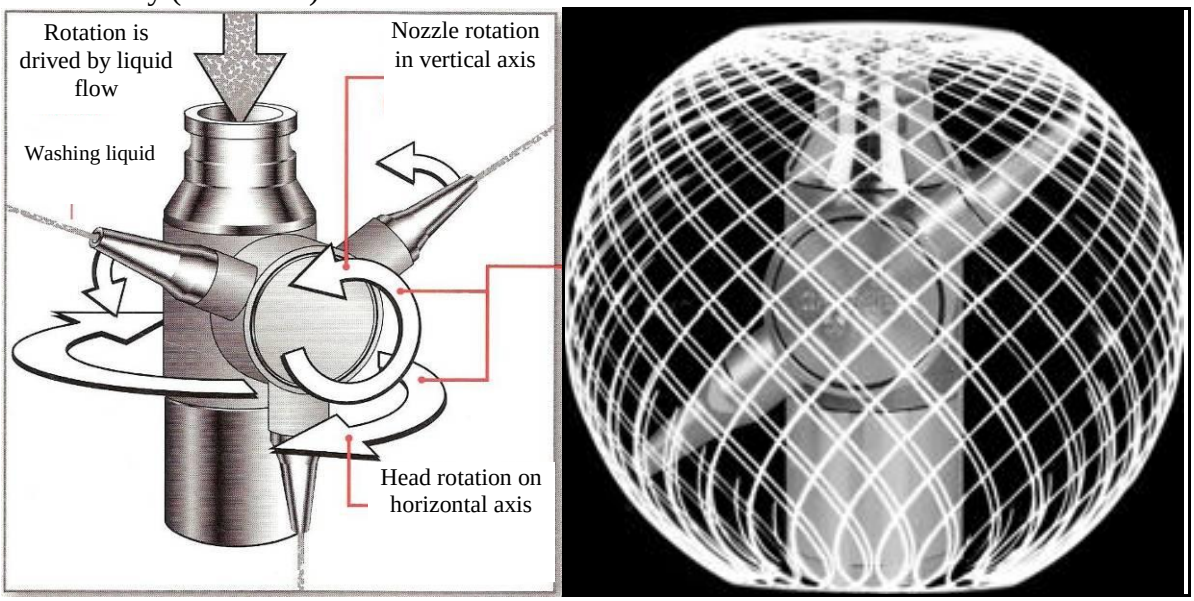


Photo #3-4. Extending telescopic apparatus (continued).

Telescopic apparatus with washing heads specially designed to safely and effectively wash tank internals, especially unreachable parts in the car ends. Before such apparatus was designed regular manway adaptor with a single washing head was used. This approach was not very effective in such places.

Photo #5. General view if two and three nozzle orbital washing heads (stainless steel or bronze).

Orbital washing head is rotating in horizontal and vertical axes and driven by washing liquid pressure only (See Pic. 1).



Pic. 1. Principle of washing head operation.

Pattern formed by water jets covers all internal surfaces of the tank.
Strong jets heat and dilute bottom sludge by heated washing solution and strong impact. Such jets impact has greater effect on sludge dilution that simple sludge heating. However kinetic energy of water jets lessens with distance increase from the orbital washing head nozzle. Thus system with one central washing head usual has greater efficiency in central part of the tank (near manway) and is declining toward tank' ends. To speed up cleaning, operator should enter inside the tank and complete work manually by scrapping it and using hand water gun. This method is not safe and requires long hours of manual labour.

Proposed hydraulically actuated telescopic apparatus with washing heads simplifies and speeds up cleaning process while provides high efficiency and cleaning quality at the car ends by delivering washing heads much closer to the cars ends.

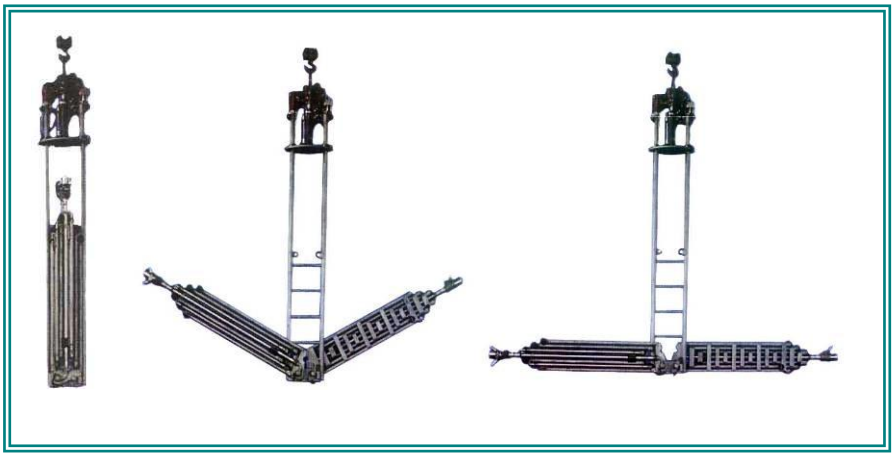
Pic. 2. Extended and unfolded telescopic apparatus inside car.

3.1. Telescopic apparatus installation.

Photo #6. Telescopic apparatus installation on the car manway.

Folded telescopic apparatus is lowered to the cars manway by on-board equipment or other lifting device. Later on, telescopic apparatus will be unfolded to the working position with hydraulic actuators. Apparatus equipped with two orbital washing heads which allow washing both car sides at same time. Washing cycle of car internals can be started as soon as a telescopic apparatus is unfolded, while it will slowly extends to a maximal length, which also reduces required washing time. After washing cycle ends telescopic apparatus retracts and folds in reverse order and then lifted from the car.

Washing solution heated to 80°C will be used in washing cycle. High pressure liquid jets provide maximum impact and cleaning effect to remove sedimentation and residual product from tank walls.

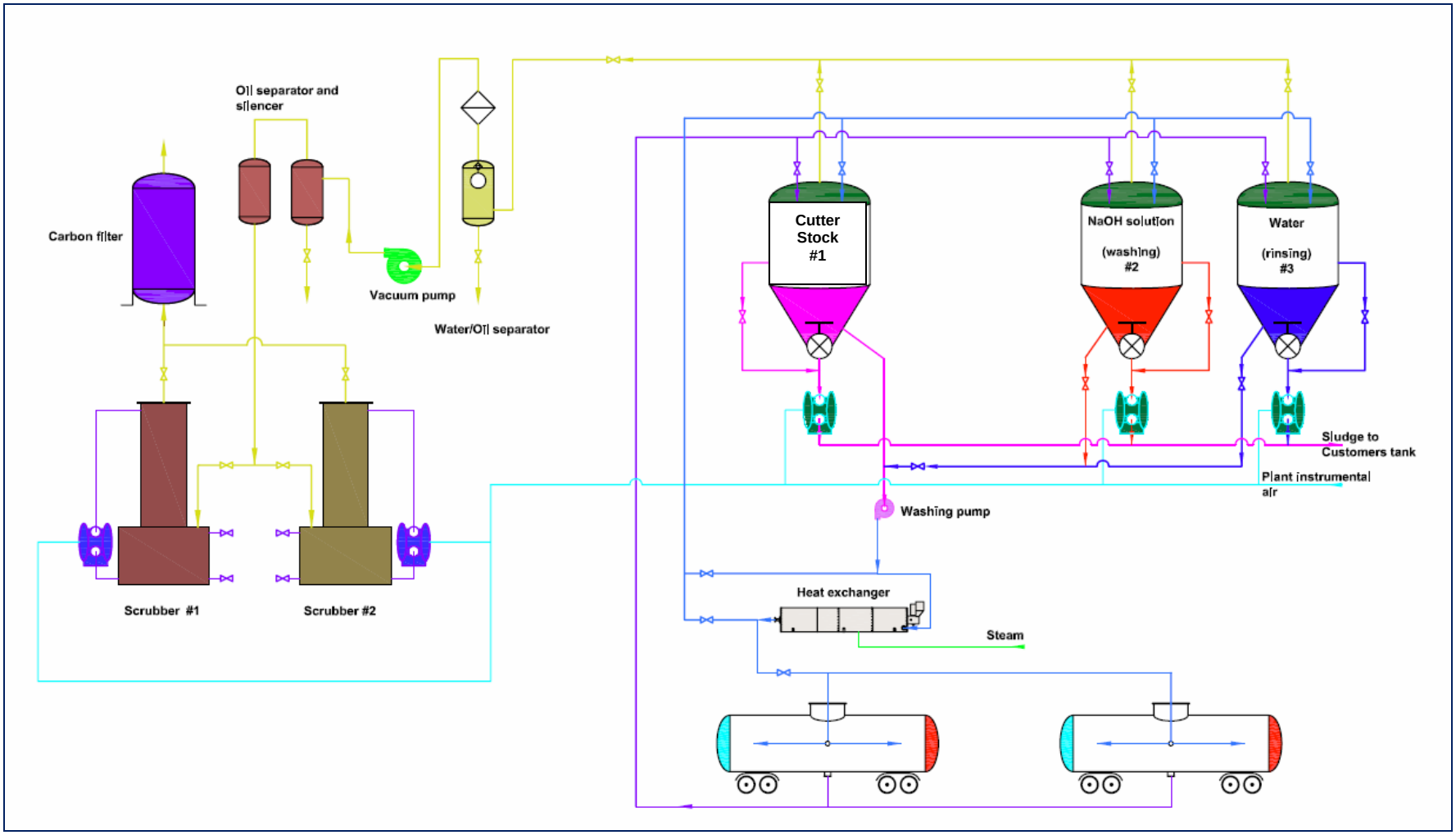


Pic. 3. Three positions of washing telescopic apparatus.

4. Washing process description

Washing agent is preheated in recirculation cycle where it flows from storage tank through strainer, main washing pump, heat exchanger and then back to storage tank.
After washing agent reach required temperature washing cycle will be started.
Following is the cleaning sequence for tanks carried heating oil (See Pic. 4). Washing pump delivers washing agent (cutter stock) from tank #1 through strainer and heat exchanger to the washing heads on the telescopic apparatus previously installed with crane on the car manway.
The effect of high temperature and high pressure washing agent, flowing through orbital washing heads, softens and washes away sedimentation and sludge from internal surfaces of the tank.
Washing agent with suspended residual product and sediments is returned to the tank #1 from the washed car by vacuum.
Vacuum is created by vacuum pump in the tank #1. Exhaust from vacuum pump is cleaned in one of the scrubbers (depending on the car tank product). Vapours at the scrubber are cleansed by continuous flow of water and active agent. Gases can be additionally cleaned after scrubber at the active carbon filter. Loss of product will be reduced by recovering it from the vapours in scrubber. Liquid sprayed in the scrubber condenses some vapours which then can be added to process tank.

Pic. 4. Diagram of washing process for car after heating oil (heavy oil).



Washing agent separates by gravity in the tank #1. Heavy phase collected in conical bottom part and periodically pumped (as soon as sufficient level is reached) by diaphragm pump to the Customers sludge collection tank.
During washing cycle washing agent is slowly saturated with heating oil that reduces its washing properties. To avoid this, part of washing agent will be removed as a sellable product (high quality heating oil) and additional fresh washing agent (cutter stock) will be added. Two cars can be washed simultaneously. Washing process for both cars is identical.
After first washing cycle is completed, second cycle, by heated caustic solution from tank #2 is started which then is followed by rinsing with hot water from tank #3.
Washing process with caustic solution or following hot water rinsing is similar to described previously. Sludge and solids collected in conical tank bottoms are periodically pumped to storage tank supplied by customers.
Floating oil and foam rising to the surface are collected on weir plates installed inside tank.
Part of the removed washing solution, has to be replaced by fresh agent. Washing agent can be reused many times. Washing solutions can be stored for farther usage to wash car tanks used for same or similar petroleum products.
Similar to washing with cutter stock, caustic solution and rinsing solutions are returned to process tank by vacuum created by vacuum pump in the process tank. Vapors and gases from stainless steel vacuum pump are cleaned in scrubbers by continues flow of liquid. Cleaned gases after scrubber can be additionally filtered on carbon filters before they are discharged to atmosphere.
When tank with high residual petroleum product and high sediments amount are cleaned, washing agent and solutions become highly contaminated. To check their quality, samples should be taken and analyzed periodically. If required washing agent and solutions should be replaced or diluted with fresh solutions from storage tanks.

5. Factory ready module units

Highest quality parts are used during equipment production. All equipment is grouped to several modules mounted on frames. Module size allows easy transportation without damaging equipment (See Photo #7). When modules are delivered to the site they can be easily assembled according to assembly plan, utilizing easy access to piping and cable connections. Minimal time required for the complete assembly.
Factory module preassembly and vigorous testing guaranties high quality and reliability as well as final assembly and startup time reduction.
Hydraulic drives and actuators widely use through the system. Only time tested and approved hydraulic equipment (hydraulic motors and control devices) used in system production.

Photo #7. Factory tested module unit ready for shipment.

Photo #8. One of modules installed it the railroad car tanks washing shop.

6. Operation safety

Proposed washing system practically excludes personal exposure to petroleum products. Telescopic apparatus use of heated solutions under high pressure effectively replaces manual labor.

Only explosion proof or intrinsically safe equipment is used in order to guarantee safety of working personnel. Wide usage of hydraulic drives and controls as well as explosion proof electric motors guarantees system fire safety.

7. Process automation

All washing cycle are performed in automated mode by Allen Bradley PLC controller that allows exclude possible personnel errors. Operator determines oil product type in the tanker or railroad car and enters corresponding program using operator touch screen (See Photo # 9). Then system will carry on automated washing cycle. Control panel for two railroad car (or tanker) system have two mirror sets of control panels to control two washing systems simultaneously.

Control panel is equipped with recording device to log process and operator input in real time. System requires 2-3 persons (one operator and one/two supporting personnel) in each shift.

Control panel general view shown on the Photo # 9. Control buttons are placed on the top of the screen. Washing cycle type is selected depending on product transported.

All major parameters are displayed on the operator screen (tank liquid levels, temperatures etc), as well as current equipment state (pumps, automated valves etc).

If emergency conditions are detected alarm message will be displayed on the screen.

System operation does not require any previous experience from operator.

KMT International Inc developed 2 days training program which allows operators to operate system with no supervision upon completion.

Photo #9. Control panel with touch screen.

As a result of installation of control panel on a service platform, operator can directly communicate with supporting personnel, who are responsible for lifting and installation of telescopic apparatus and connecting hoses to the tank draining equipment. Movable gangway for each module allows easy access to manhole by personal.

Telescopic apparatus is supported by pneumatic crane on the gangway (as shown in Photo #10). The responsibility of support personnel includes; lower telescopic apparatus and secure it on the manway.

Photo #10. Washing apparatus gangway with crane.

8. Environment control

All equipment designed in compliance with the requirements of EPA in USA.

8.1. Vapors and gas processing.

System is equipment with gas cleansing and filtering unit. Unit includes two scrubbers and active carbon filter to clean gas before discharging it to the atmosphere. Scrubbers have continuous sprays of water based solutions depending on product of railroad car tank. Exhaust gases treated on gas processing unit complied with EPA requirements.

8.2. Product recovery.

Great efforts are made to recover product during washing process which is normally lost in most washing systems. Product recovery reduces waste product created in washing process and minimize environmental impact. Recovered product can bring additional revenue to the customers. The amount of recovered product can reach 1-5% from the railcar volume depends on ambient temperature when product was unloaded at the destination and time since car was previously cleaned. At winter time railcar may contain more than 5% of residual amount of heating oil. At summer time amount of residual product is not more then 1-2% from car volume, depending on night time temperature and time limit to unload product required by railroad operator. Quality of recovered product makes it marketable.

9. *Preliminary system dimensions*

Single railroad car washing system with throughput of 30-40 car tanks per day requires building with approximate dimensions: 15 m x 4.5 m. Building should comply with national and local fire safety and environmental requirements for industrial buildings.

10. Scope of supply for single rail road modular car washing system

Module unit includes following items:

- Power unit.
- Main washing unit.
- Vacuum pump.
- Environment control system including scrubbers and gas filter.
- Control unit.

10.1. Power unit (hydraulic power station with explosion proof electric drive) – 1 ea.

10.2. Washing unit:

- Tank *V= 9.5 cubic meters* with conical bottom and elliptical top – **3 sets.**

Each tank is equipped with

- Manway (diameter 508 mm) to access to car internals,
- Manifold (diameter 203 mm) with glass view port and bucket strainer.
- Weir plate skimmer with drain pipe diameter 76.2 to pump skimmed product.

Each tank insulated with urethane foam.

Foam is covered with vinyl skin before painting.

10.3. Process pumps:

- Main washing pump – 1 ea.

Centrifugal pump 2 x 3 x 13.68 cubic meter per hour @ 14 atm, 75 HP explosion proof electric motor. Strainer on the pump inlet. Pump base from malleable iron, impeller and pump body from stainless steel. Mechanical seal "John Crane". Pump frame from cast iron.

- Duplex diaphragm pump – 3 ea.

Duplex Diaphragm pumps, 65 cubic meters per hourc @ 8.8 atm.

Pump body malleable iron with aluminum air chamber. Air valve from brass. BUNA M or Teflon seals.

10.4. Heating unit for washing and rinsing solutions (tube and shell heat exchanger with automated temperature control) – ***1 set.***

Tube and shell heat exchanger - 625.000 ~ 750.000 kcal per hour, shell form carbon steel, pipes – stainless steel. Heat exchanger complies with ASME requirements. Max pressure inside heat exchanger shell 10.5 atm, max pressure inside tubes – 21 atm.

10.5. Telescopic apparatus – 2 sets.

Each telescopic apparatus have two orbital washing heads.

Construction type – reinforced frame.

Material: Parts not in contact with washing solution made from carbon steel and cast iron. Part in contact with washing solution made from stainless steel, bronze and plastic..

Max liquid flow – 68.2 m^3/hour (300 GPM).

Max. work pressure - 21 atm (300 PSI).

Max work temperature of washing solution - 93^0C (200^0F).

Minimal unfolded and extended length of telescopic apparatus - 4318 mm (170“) with min. distance between washing heads.
Max unfolded and extended length of telescopic apparatus - 10058 mm (396”) with max. distance between washing heads.
10.6. Storage tanks for fresh (clean) washing and rinsing solutions (10 m^3 capacity each) with all required piping, fittings and pumps to replenish liquids in process tanks (***supplied by the Customer) –3 ea.***
10.7. Vacuum pump:
- Vacuum pump– 1 ea.
Demag Whitting RFL-100 vane vacuum pump with flow 628 m^3/hour @ 457 mm Hg, 30HP explosion proof electric drive. Filter on inlet line. Silencer and oil separator on exhaust line.
10.8. Environment control unit.
- Two venture scrubbers condensers, mounted on common frame – ***1 set.***
- Carbon filter - for final gas cleaning before discharging to the atmosphere – ***1 set.***
10.9. Piping, air actuated valves and hand valves. Two high pressure hoses (length – 6.1 m, diameter – 50.8 mm) to connect to the washed tank. Two hoses (length – 6.1 m, diameter – 76.2 mm) – return line to process tanks. Two adapters to connect to the railroad car tank drain devices.
10.10. **Control panel and instrumentation – 1 set.**
10.11. **Frame** (length - 12.20 m, width – 3.05 m, height – 3.66 m), used to mount control panels, with top grate surface, stair case, hand rails, movable gangway and pneumatic crane to lift and install telescopic apparatus.

11. Additional services provided by KMT International, Inc

In addition to system manufacturing KMT International Inc. will provide following services to the customers at additional cost:

- Technical documentation in English (Other languages upon request) including installation, operation, maintenance and repair manuals,
- Export packaging for sea transportation,
- Equipment delivery to the customer in terms of DDU, including freight insurance during transportation.
- Installation supervising,
- Personnel training according to training program provided by our specialists,
- Warranty and after warranty system service.

12. Warranty

All system covered by 12 months warranty starting from system startup day but not more than 18 months from date the system is shipped, whichever comes first.

13. Delivery time

Lead time for system delivery is 7-8 months starting from the date contract signed and first payment is received.

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