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		Pickling and passivation procedure			
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1. SCOPE

This Standard covers the minimum requirements for Internal Cleaning of Piping Systems on upstream side of process machineries and lube oil/seal oil systems for which removal of rust, mill scale, grease and foreign matters is essential.

2. CLEANING PROCEDURE

2.1 Normal Cleaning


Prior to chemical cleaning operation, normal cleaning shall be performed by flushing and/or mechanical means, as applicable.

2.2 Chemical Cleaning

All piping indicated on the drawing or otherwise specified shall be chemically cleaned in accordance with this Standard.

2.2.1 Preparation for chemical cleaning

- a) Generally, installed piping shall be cleaned in place after hydrostatic testing has been completed, the systems shall be checked for leaks, prior to cleaning by chemicals. Cleaning may be performed in a bath and/or by soaking or alternately portions of piping systems may be connected together in a predetermined location and cleaned using the circulation method unless field conditions dictate otherwise. However, after cleaning has been performed, no further welding work shall be carried out, except seal welding of small connections.
- b) Piping to be cleaned shall be disconnected or blanked off from mechanical equipment. Chemicals shall not be circulated through bearings, cylinders, oil filter cartridges, instruments, screens and filters. Valves and equipment may be included in the circulation system provided that their materials are resistant to chemical solutions involved and prior approval of the Engineer is obtained. Otherwise, the Executor is responsible for any possible damage which may occur due to chemical reaction between the parts and the chemical, and shall replace the damaged parts at his own expense.
- c) The Executor, in preparing his circulating system, shall ensure that circulation is complete and that there are no dead ends or branches that will create traps. The Executor shall make sure that there are adequate existing high point vents and low point drains in the circulation system. If additional high point vents and low point drains are required, they shall be installed by the Executor after obtaining Engineer's approval.
- d) The portable pumping set provided by the Executor shall be capable of safe handling of the chemicals to be used. The pump design shall be such to have the desired capacity and shall be capable to circulate the chemical at velocity required for cleaning of piping system.
- e) Prior to pickling, all heavy deposits of oils, greases, soils or foreign matter other than mill-scale, rust or rust scale shall be removed by precleaning as cited in 2.1.

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f) Exposed flange faces and pipe threads shall be protected from chemical solutions.

g) All solutions, during the recirculation sequence shall be filtered. Full flow filter or equipment shall be equipped with screen capable of removing particles that are 4 micron or more in diameter.

h) The Executor shall prepare chemical cleaning procedure. This procedure shall be approved by the Engineer prior to implementation. The procedure must include but not limited to the following items:

- The result of the tests on composition of precipitates.
- Precleaning.
- Exact compositions (percentages) of cleaning solutions and inhibitors.
- Inhibitors to be used to prevent corrosion and hydrogen -brittleness.
- Temperatures of the solutions during cleaning.
- Circulation times.
- Indication when the solutions will be renewed; concerning; Iron content, acid concentration, pollutions, etc.
- Corrosion to be expected (Degree of attack and uniformity).
- Flow velocities.
- Neutralization.
- Passivation.
- Flushing and drying.
- Preservation after cleaning.
- The number and installation points of corrosion coupons;
- Points of sample taking.

2.2.2 Consideration to be given in chemical cleaning

2.2.2.1 Only clean fresh water (e.g. tap water) shall be used in preparing the acid concentration where pickling is performed in carbon steel or low alloy steel piping. Distilled or demineralized water shall be used in preparing the acid concentration where stainless steel piping is subject to chemical cleaning.

2.2.2.2 The pickling time shall be kept to a minimum.

2.2.2.3 The acid solution must not be allowed to stand undisturbed in any part of the system at any time.


2.2.2.4 Acid, inhibitors and neutralizers shall not harm the various materials of the system to be cleaned and shall be in accordance with accepted practice.

2.2.2.5 Before changing from one to another fluid, the piping must be allowed to drain sufficiently so that as little acid or water as possible is mixed with the subsequent fluid.

2.2.2.6 Process pumps shall not be used to circulate the acid solution.

2.2.2.7 All heating has to be external to the systems being cleaned. Live steam shall never be introduced into any part of the system.

2.2.2.8 Passivation shall be performed immediately after neutralization process.

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2.2.2.9 In addition to all instruments (e.g. flow meters, thermowells, pressure gages, etc.), equipment, valves and other materials which may be attacked by the acid, corrosion coupons other than corrosion coupons which are required for pickling shall be removed from the system intended for cleaning.

2.2.2.10 Suitable acid resistance gate valves shall be installed on the point of vent and drain by the Executor.

2.2.2.11 Installation point of instruments shall be tightly plugged after removal of the instruments.

2.2.2.12 Suitable spools shall be installed in place of removed valves and equipment.

2.2.2.13 During pickling with circulating system the velocity of the flushing, rinsing, acidizing, neutralizing and passivating shall be kept within the range of 90 to 150 cm/sec. (3 to 5 ft/sec.)

The power and capacity of the pump(s), size of connections and their set up shall be so that the above mentioned velocity range can be maintained in all parts of the system to be cleaned and there shall not exist dead ends.

2.2.2.14 The metal composition of piping to be cleaned should be provided to Executor prior to pickling for selection of suitable acid and pickling procedure.

2.2.2.15 The volume of the systems to be pickled shall be calculated by the Executor prior to commencement of the pickling.

2.2.2.16 The volume of the tank which shall be used for circulation process shall be at least 10% more than that of the system which has the largest volume and is subject to pickling.

2.2.2.17 For taking samples during pickling process suitable points near the inlet and outlet of cleaning system shall be selected. These points shall be approved by the Engineer and sampling facilities shall be installed at these points.

2.2.2.18 The Executor must include in his procedure the methods by which he intends to check acid solution in order to maintain the recommended concentrations (i.e. hydrometer, titration etc.).


2.2.3 Tests to be performed prior to pickling

Prior to pickling a sample shall be taken from deposit of each system to be pickled and analyzed by the Executor. The percentage of the following items in the deposit shall be determined using test methods (ASTM D-887).

- Iron content (including Fe⁺⁺ and total Iron)
- Silica
- Carbonates
- Phosphates
- Hydrocarbons

Based on result of the tests decision shall be made for the type and concentration of acid to be used and pickling procedure.

2.2.4 Cleaning of carbon steel piping by pickling

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Proceeding outlined below gives requirements for various processes of pickling. The cleaning procedure proposed by the Executor shall include, but not limited to these requirements.

Circulation process shall be adopted for chemical cleaning of carbon steel piping unless, in special conditions where this process appears to be impractical; in such instances approval of the Engineer shall be obtained for using other process of pickling.

If equivalent chemicals are intended to be used it shall be clearly stated in the Executor's proposed procedure.

2.2.4.1 Pickling by circulation process

The following steps shall be taken in circulation process:

a) Flushing

Prior to pickling the system shall be flushed with clean fresh water (potable water is accepted). The system shall be checked for leaks. If any leak is observed the executor shall take remedial action to stop the leak and flushing shall be continued until the visual inspection of outlet water indicates it has same appearance of inlet water.

During flushing water velocity shall be kept within the range of 90 to 150 cm/sec. (3 to 5 ft/sec.); it is preferred to stick to about 150 cm/sec. During flushing the system shall be packed with the water and no air shall be present in high points.

b) Degreasing

After completion of flushing, degreasing shall be commenced to eliminate presence of oil and/or paint stucked to the inside surface of pipe. A solution of Soda ash with concentration of 1 to 3 percent together with 0.05 percent penetrating agent and 0.5 to 1 percent three Sodium phosphate as additive should be used for degreasing. During degreasing operation, the solution temperature shall be maintained between 70°C and 80°C. The following solutions may also be used as alternative provided that approval of the Engineer is obtained.

1) 10% by weight solution of technical grade sodium hydroxide with 0.05% penetrating agent at temp. range of 65 to 80°C.

2) Alkaline degreasers. The degreasing solution shall be circulated in the system for 2 hours then it shall remain stagnant for 12 hours; thereafter the solution shall be circulated for one to two hours and finally drained.


During degreasing, tests shall be made for the followings at one hour intervals:

- Soda content of the outlet fluid.
- pH value of the outlet fluid.
- Oil content of the fluid.

Presence of sufficient active Soda in the system outlet is indicative of satisfactory completion of the degreasing operation.

c) Rinsing

After completion of degreasing, flushing with clean fresh water in ambient temperature with the same procedure as described in Section 5.2.4.1(a) shall be conducted. Rinsing shall

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be continued until a pH value of 7 to 8 is achieved as indicated on hydriion paper or equivalent.

d) Acid wash

After rinsing, acid wash shall be started, especially where system valves are included in the operation, it is necessary to utilize an inhibited phosphoric, hydrochloric, sulphuric or less aggressive organic acids. Type of the acid shall be chosen based on the result of test on deposit to be removed (see Clause 5.2.3).

The Executor shall exercise care and take necessary precautions against the followings:

1) The Executor shall ensure that there are no alloys other than carbon steel in the system which is subject to acid wash.

2) The Executor is responsible to make sure that all spent acid solutions are effectively inhibited.

3) The duration of acid wash operation must not be of such length to give greater than 5 microns (0.2 mil) general metal loss on the most vulnerable alloy, weld and heat affected zones, or galvanic couples in the composite metallurgical system. No pitting will be accepted. Metal loss may be determined by thickness measurements on pipe body or installation of corrosion test coupons.

4) The difference between Iron ions at the beginning and during acid wash shall not exceed 5000 ppm by weight. If this difference exceeds 5000 ppm, it means that no proper acid and/or inhibitor is used and the pipe metal is being solved in the acid. In this case the acid wash shall be immediately stopped and the acid be drained from the system followed by proper rinsing until the pH of 7 to 8 is achieved. Then the type and concentration of acid and inhibitor shall be changed. This change shall be approved by the Engineer prior to resumption of acid wash.


The concentration of the acid shall be chosen so that 80 to 95 percent of the precipitates on the pipe body can be dissolved in it within a period of 6 hours.

Based on the type of acid, suitable inhibitor shall be used. If the tests mentioned in 5.2.3 indicate presence of Silica in deposit, hydrofluoric acid or one of its salts with suitable concentration (as indicated earlier in this Standard) shall be added to the solution.

The acid shall be injected into the system and circulated at velocity of 90 to 150 cm/sec. (3 to 5 ft/sec.) for 6 to 8 hours. During acid wash following tests shall be conducted. Time intervals of the tests can be one hour but it shall be reduced to half an hour after 6 hours of circulation. The tests shall determine followings:

- PH value of acid
- Percent of acid
- ppm of Iron (Fe⁺⁺ and total Iron)
- Percent of silica

At the end of the acid wash all rust, mill scale and foreign materials shall have been removed from the system. If visual inspection reveals presence of these matters the acid wash shall be repeated with the time interval which shall be approved by the Engineer.

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e) Rinsing with fresh water or removal of acid by Nitrogen gas

After acid wash the system shall be rinsed using clean fresh water. Nitrogen gas may also be used for removal of acid. If fresh water is used for rinsing, it shall be circulated until pH value of 7 is achieved.

If Nitrogen gas is used for acid removal, it shall be injected from vent (highest point) and the spent acid be drained from the lowest point, until all fluids is drained.

f) Rinsing with organic acid

After rinsing with fresh water or acid removal by Nitrogen gas, the system shall be rinsed with citric acid with concentration of 1% for removal of free iron ion which is not removed by water rinsing (or Nitrogen gas). The duration of this step shall be 1 to 3 hours at ambient temperature.

g) Rinsing with fresh water or displacement with Nitrogen gas

After step "f" the system shall be rinsed once again with fresh water or displaced with Nitrogen gas as indicated in Paragraph "e" above.

h) Neutralization and passivation

After step "g" Neutralization and passivation shall be performed as one step. The solution shall be 1 to 3 percent by weight Soda ash with 0.5 to 1 percent three sodium phosphate or 1% NaOH or 0.6% Sodium Nitrate (Nitron). It should be noted that Nitron is preferred to other additives.

The solution shall be circulated for 2 to 4 hours with a temperature of 50 to 60°C.

i) Flushing and drying

After steps "a" to "h" are completed, the system shall be flushed with hot dry air until the system is completely dried. The dew point of spent air shall be lower than the minimum ambient temperature.

2.2.4.2 Pickling by soaking process


In chemical cleaning by soaking process the same concentrations and temperatures specified in circulation process shall be used and the same steps shall be followed except that the fluid(s) shall be injected from the lowest point of the system (drain) and air (or previous spent fluid) shall be vent from the highest point (vent). Since there is no movement of fluid(s), the duration of acid wash with soaking process shall be kept longer than that of the circulation process, but in any case the end of each step shall be determined as indicated in circulating process (steps a to in Clause 5.2.4.1).

2.2.4.3 Pickling by dipping process

In dipping process a bath shall be prepared with a size that the biggest portion of piping system can be immersed into it. Then fluids with the same concentration and temperature as indicated in Paragraph 5.2.4.1 shall be used and same steps as those cited for circulation process shall be followed for dipping the piping system into the fluid baths.

2.2.5 Pickling stainless steel piping

Pickling of stainless steel piping should be avoided, but if project specification calls for it stainless steel piping may be chemically cleaned as per detail procedure cited in Clause 5.2.4 taking the following exceptions into account:

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2.2.5.1 Only distilled and/or demineralized water shall be used in flushing, rinsing, preparation of acids, neutralizing, passivating and degreasing fluids.

2.2.5.2 Only phosphoric acid, sulphuric acid and/or organic acids shall be used for acid wash. Requirements given in Clause 5.2.4 in respect of concentration, temperature, and duration of pickling shall be adhered to.

2.2.5.3 Hydrochloric acid shall not be used in any circumstances.

2.2.5.4 Chloride concentration during pickling process shall never exceed 1 mg/kg (1 ppm by weight) before, during and after pickling.

2.2.6 Protection of cleaned piping

After completion of acid wash and subsequent drying of piping system, the hot air shall be completely displaced with Nitrogen gas. The system shall be tightened to obviate leakage of Nitrogen gas to open atmosphere and a positive pressure shall be maintained until the commissioning process gets started.

2.3 Other Cleaning Methods

2.3.1 Removal of rust

The system should first be degreased by circulating water at 80 °C and adding a suitable degreasing agent. The solution should be circulated at this temperature for 2 hours. The system should then be drained and washed out with water to the process water effluent treating system. The rust can then be removed by circulating inhibited 2% to 5% by weight hydrochloric acid until a sample shows that the reaction is complete.

Finally, steam condensate should be circulated at 40 °C and a passivating phosphate mixture added until a 2% solution is obtained. The solution should be circulated for 2 hours.

The system should then be drained to the process water effluent treatment system, and then dried with air.

2.3.2 Cleaning without circulation

For cleaning piping systems without circulation facilities, a trailer with tanks, pump and heating facilities should be connected to each end of the system. The cleaning agents should then be pumped from one trailer to the other, as often as required.


Note:

All instrumentation components, all relief valves and all components susceptible to metallurgical attack shall be removed or blanked off.

2.3.3 Steam blowing

The purpose of steam blowing is to remove debris, loose scale and rust from recently welded or renewed steam lines suitable for steam turbine operation. The effectiveness depends on the steam velocity, the change of temperature in time and the number of blows.

Line cleaning should not commence until all related piping and process equipment are fully installed, the system has been checked for conformance with the piping and instrumentation diagrams, and the piping systems have been hydro tested. Temporary piping and silencers for depressurizing to atmosphere should be properly anchored.

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All restrictions in the piping such as orifice plates, flow measurement tubes and thermo wells shall be removed prior to steam blowing. Control valves shall be replaced with spool pieces.

Steam should be blown from a clean system to uncleaned systems. In order to thermally shock the piping to remove mill scale, the steam valve controlling the blow down should be of the quarter turn type (quick opening).

The valve should be located well upstream of the piping to be cleaned. At the inlet flange of the silencer, a target strip of polished copper or aluminum shall be clamped to judge the finished cleanliness. Blows should first be made at low pressures to remove large objects in the piping, gradually raising the pressure during later blows to the maximum operating pressure. Between the blows there should be a cool down period of at least 60 minutes for uninsulated pipes and 240 minutes for insulated pipes. A system is considered to be acceptably clean when the target plate has less than a predetermined number of impact pock marks. The following requirements apply for blowing steam lines:

- Steam flow during blowing shall be at least three times the maximum flow rate during operation;
- There shall be not more than one total particle count (pock mark) per square centimeter of target plate surface;
- There shall be no evidence of embedded material (e.g. weld splatter, sand, etc.). Target plates shall not show individual rough impressions;
- The blowdown shall be of not less than 10 minutes duration;
- At least 15 blows shall be made;
- If the piping is not to be put immediately into service, the system should be purged with nitrogen to remove any air and should be placed under an inert nitrogen blanket.


2.3.4 Air blowing

If it is not possible to achieve the necessary steam velocities required for steam blowing or if it is not convenient to use steam because of the possibility of residual liquids in the line that may damage machines or instrumentation, air blowing should be substituted.

Examples of this are fuel lines and instrument air lines. Preparations are identical to those for steam blowing.

Air is usually supplied from temporary high-pressure large-capacity air compressors because the permanent instrument air compressors do not normally have sufficient capacity. These temporary air compressors are supplied with aftercoolers and coalescers to remove oil from the compressed air system.

An air reservoir shall be available during the blowdown process. The piping is then cleaned by pressurizing the piping system and then opening a temporary quick acting valve to allow depressurization (via a silencer) to atmosphere.

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3. INSPECTION

3.1 The Engineer reserves the right to inspect and/or supervise cleaning at any step of the operation and to make any check deemed necessary to ensure that the desired degree of cleanness has been achieved.

3.2 During chemical cleaning in addition to the tests listed in Clause 5.2.4.1 the attack of the surfaces shall be checked by using pretreated steel plates. These tests shall be performed according to the Attachment A adopted to the field condition with approval of the Engineer.

4. SAFETY AND ENVIRONMENTAL PROTECTION

Before starting any chemical cleaning operation, adequate measures for safety and protection of the environment shall be established. All local regulations shall be complied with and the Company's requirements shall be observed.

The cleaning area shall be closed off to unauthorized personnel.

Warning signs shall be posted to forbid smoking, welding, flame cutting and unauthorized entering of the cleaning area.

Cleaning agents, inhibitors and chemicals shall be transported in closed containers, drums or tanks.

Where necessary, adequate drip pans shall be placed to avoid soil contamination (either by oil or cleaning liquid). Disposal of liquid leakage should follow the same procedure as for bulk liquids.

Protective clothing shall be worn and other protective equipment (face shields, special gloves) shall be used during cleaning and when handling cleaning agents.

An emergency shower with eye bath shall be available to wash away splashed hazardous chemicals.


During cleaning with acid, adequate venting shall be provided to prevent the accumulation of any explosive gas mixture; special measures (ventilation) shall be taken to vent isolated pockets in a safe manner.

Dilution of acid shall always be effected by slowly adding the concentrated acid to water, stirring to avoid splashing and to prevent the temperature from rising above 75 °C. When cleaning austenitic stainless steel, demineralised or condensed water shall be used for dilution purposes.

Arrangements shall be made for the safe and environmentally acceptable disposal of used cleaning agents via a neutralization unit or disposal tank. Direct disposal to a sewer may be performed only after neutralization and on confirmation of environmental acceptability. If the disposal tank contains organic cleaning materials or contaminants, biotreatment shall be applied.

Ammonium bifluoride is a toxic substance and appropriate precautions shall be taken (when handling concentrated solutions, face masks, rubber gloves and leggings are advised).

Arrangements shall be made for the safe disposal of gases released during cleaning, including toxic gases such as hydrogen sulphide and sulphur dioxide.

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During chemical cleaning of equipment containing sulphurous compounds such as iron sulphide, hydrogen sulphide will be released and strict precautions shall be taken. The gases formed during the chemical cleaning process should be routed to a caustic absorption pot to absorb the released hydrogen sulphide. The discharge from the pot shall be routed to a safe location for venting. The discharge from the vent shall be carefully monitored to detect hydrogen sulphide breakthrough so that the caustic charge in the absorption pot can be replenished. After the chemical cleaning or whilst changing the caustic inventory of the absorber pot it must be assumed that hydrogen sulphide is still present, possibly at a slight overpressure. Therefore, replenishing or removal of the caustic pot must be done with great care, taking hydrogen sulphide precautions such as:

- Purging the vapor space of the vessels included in the acid cleaning circuit, via the pot To atmosphere;
- Performing a gas test for hydrogen sulphide when removing the caustic pot;
- Use of breathing apparatus when removing the caustic pot.

During acid cleaning, agitation with air shall not be performed as this may result in the formation of explosive hydrogen-oxygen mixtures. Agitation with nitrogen may be applied. The presence of mercury is possible, particularly when processing hydrocarbon condensate from gas fields. Mercury traps are used to prevent contamination of process unit equipment. The release of mercury and its compounds to the environment shall be prevented.

5. REASSEMBLY

After the cleaning operations, pipes, fragile devices, etc. have to be reassembled. A great care is necessary in this operation.


The construction specifications have to be complied with, with a particular emphasis on the following points:

- Gaskets, ring joints, etc. have to be carefully cleaned.
- Spring supports, sliding pads, etc. have to be installed according to the drawings and released when the re-assembly is completed.
- Threads shall be checked and wrapped with PTFE.
- Stuffing boxes and packing of valves shall be checked and changed if necessary.
- Absence of stresses on pumps and compressors flanges has to be checked.
- The orientation of check valves, globe valves, etc. shall be checked (according to their arrow) against the direction of flow.
- In-line instruments such as flow orifices, restriction orifices, rotameters, shall be installed by instrument specialists.
- Expansion bellows shall be freed according to the Manufacturer's instructions.

Tightness tests, followed by functional tests shall be made after re-assembly.

6. DOCUMENTATION REQUIREMENTS

Chemical cleaning procedures, and test results shall be submitted to the Engineer on completion of chemical cleaning and prior to commissioning of the system. The documents shall include but not necessarily limited to the followings:

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6.1 Approved Chemical cleaning procedure.

6.2 Flow diagram of the system(s) which have been chemically cleaned.

6.3 A certificate signed and approved by the Engineer showing that all piping system which require internal cleaning have been satisfactorily cleaned based on approved procedure.

6.4 The test results conducted before, during and after chemical cleaning.

6.5 The preservation system including the type of purging fluid and the pressure of the system(s).

