Cleaning and Flushing of Chilled Water Piping

This statement provide a method for the cleaning, flushing and passivation for the HVAC chilled water system in the site itself to be followed by the third or independent party.

Objective:

The objective of cleaning, flushing and passivation is to remove debris such as silt, scale, iron oxide deposits, weld slug, and other contaminants that are present in a new pipe work system, The passivation process inhibits the system from corrosion.

The process of the pre-operational flushing and cleaning becomes more important as if these contaminants are to remain in the system then it directly affect the cooling system efficiency and reduces flow through the system.

These contaminants also prevent formation of uniform protective passivating layers which further leads to corrosion in the system.

Based on the above, it is of paramount importance to ensure that the proper pre-operational cleaning/flushing program is carried out before the system is put into normal operation.

CHILLED WATER TREATMENT:

Chilled water system is the system having re-circulation in closed loop and the temperature of the system generally range from 5.5 to 14 degree Celsius.

A closed re-circulating system is one in which the water is circulated in a closed loop with negligible evaporation or exposure to the atmosphere or other influence that would change the water composition these system usually require high chemical treatment level and since water losses are negligible, these level are economical. Good quality make-up water is generally used for best system operation.

Heat Transfer to the closed cooling water loop by typical heat exchange equipment and is removed from the closed system loop by means of a second exchange of heat from the closed loop to a secondary cooling cycle. The secondary loop could use either evaporative or once through water cooling, or air cooling.

Velocity of water in closed system is generally in the range of 0.9 to 1.5 m/s.

Temperature rise usually averages 5.5 to 14 degree Celsius, although some system can exceed this substantially. Generally closed system require little or no make-up water except for pump seal leaks, expansion tank over flow and surface evaporation from the system vent, This periodic make-up requires regular analysis for control of correct treatment chemical residuals.

Closed system usually contain combination of different metal, which provide a high potential for galvanic corrosion. The potential for dissolved oxygen attack is quiet high in closed chilled water system because of the presence of dissolved oxygen.

Theoretically, scale should be a minor problem in the chilled water system since the water is not concentrated by evaporation.

With high make up rate, however, additional scale form with each new increment of water added so that in time, scale becomes significant. In addition, there is opportunity for sludge, rust and suspended solids to drop out at low point and bake on heat transfer surface to form hard deposit. Therefore scale retardant and dispersant are usually included as a part of a closed system treatment program where make-up rates are high.

Because water re-circulating through a closed system is not exposed to the atmosphere, fouling by airborne silt and sand rate, however, Fouling by microbial masses may occur in closed system where make up rate is significant or process leaks encourage bacterial growth. These are controlled with biological control conditions found in a closed system.

Hence for any chilled water system mainly two problem are found.

- Corrosion

- Microbiological Fouling

CHILLED WATER PIPING FLUSHING PROCESS:

The main objective of flushing process is to remove, as much dirt and debris from the pipe works system as possible, in order to reduce the livelihood of the system blockage and create the best possible circumstances for successful chemical clean and subsequent water treatment regime.

Contaminant such as mill scale, jointing compound and the building debris will inevitably be found in newly fabricated pipe work system. It allowed to remain in the system in sufficient quality. These contaminants will make system prone to blockage at strainer, control valve and small bore heat exchanger. The micro-organism may also initiate further corrosion and may encourage the growth of micro-organism.

The first stage forward removal of these contaminants is to thoroughly flush the system with clean water. However, system flushing by itself will not removed the containment mainly metal oxide which adhere to the internal surfaces of the pipe, when the system is set to work, movement of the pipe works due to the thermal expansion or contraction, will cause the contaminant to be release back into the fluid stream. Therefore, the objective of chemical cleaning are to loosen the surface deposit so that they can be flush away and to create stable surface layer inside the pipe which it maintained by a proper water treatment regime, will resist further corrosion.

There is potential for a chemical clean to do more harm than good if it is not carried out properly. The chemical used for cleaning must be compatible with the system materials.

In particular the success of the chemical cleaning is dependent on the ability to undertake through system flushing before and afterwards, to ensure removal of the loose material and the waste chemical. The cleaning must be carried continuous operation to avoid time for further corrosion to develop, further only forward flushing alone will not remove as much dirt from the system as two stage. Forward flush / backward flush operation. This is because it is extremely difficult to move particle thought up-sweep bend or prevent them setting in unintentional traps such as valve, bodies. By flushing the system in both directions, particle, which fail to move in one direction, will move in the other direction.

The water velocity require for flushing much sufficient to pick and carry the majority of the dirt and debris of the system, Although it is quite feasible for much larger particle to find their way into system, most of the debris will be below 5mm in diameter.

Bend from the horizontal to vertical down & from down to horizontal or bend in the same plane do not retard debris movement. The need to flush from horizontal to vertical upward can be avoided in the first instance and should carried out by back flushing of the system.

APPLICATION OF CHEMICALS / METHOD OF OPERATION:

PRE-CLEANING/FLUSHING START UP CHECKLIST:

GENERAL:

Before startup of any pre-cleaning activity, the following should be considered as necessary:

- Check the availability of supply of continues fresh water (Temporary or permanent as necessary)
- Check the availability of power and electricity (Temporary or permanent as necessary)
- Check the availability of labor/manpower (24 hour basis)
- Check the availability of chemical required for flushing / cleaning operation at site.
- Check the installation work is completed.
- Identify clearly feed and drain point.
- Make provision for drain from lowest points.
- Check availability of safety equipment at site and ensure that the workers are trained in safety requirements.
- Check operation of the system pumps or temporary flushing pumps as necessary.
- Check and identify all air vents present in the circuit.
- Make the complete chilled water piping (new line) into a single slope by making necessary bypass connection to the heat exchanger, AHUs, FCUs, etc.
- The bypass connection should be sufficiently sized.
- Check and ensure that all isolating valves enabling circulation in this circuit are fully.
- Ensure that all precision valves and all cooling coils are bypassed as required.

- To the extent of its applicability on this job, safety precaution in handling of chemical should be taken on the person handling the chemical while mixing shall wear gloves and goggles, clean water will be made available at the site by the contractor. The necessary handling information for the chemical as provided in the MSDS shall be put up at the place where chemical are being dosed into the system.

Samples and Sample Containers:

MEP Contractor shall submit samples in clear bottles of a type that is locally available during various stage of the treatment (as provided in the checklist). These bottles will be labeled with information of time and location of sample point.

Preparation:

It is essential that in order to enable the flushing procedure to be completed successfully, all the item listed in the pre-cleaning/flushing start up check list which are described above are provided prior to commencement of the process.

Method of Statement for Chemical Cleaning/Flushing:

The process involve the following stages:

- Initial static flush with plain water
- Dynamic flushing
- Chemical cleaning
- Final inhibition and passivation
- Re-instatement of plant items and back flushing.

Initial Static Flushing with Plain Water:

- Fill the system with plain water using either mains supply or tinkered water and temporary pumps.
- After filling the system drain the entire system should be carried out twice.
- Fill the system again.
- Circulate the system using the system pump for 8 hours.
- During circulation, the Y-strainer in the pump suction has to visually checked and cleaned at least once an hour.
- After circulation open the drain valves at the lowest point in the system.
- Flushed water should be disposed out of the storm water drain or disposal tanks provided at site.
- The system is again refilled and dynamic flushing started.

Dynamic Flushing:

- Keep the system circulation, using the system flushing pumps.
- Open the clean water feed to the system (or temporary feed if applicable).

- Slowly open the drain valves at the lowest point in the whole system and adjust it to adequate makeup and drainage.

Note: - The drainage flow must never be more than the clean make up water flow as to avoid system pressure loss and drainage.

During dynamic flushing it is important that the velocity of the circulating water is sufficient to force all debris from the system pipe works.

Velocity Requirement:

The water velocity require for flushing must be sufficient to pick up and carry the majority of the dirt debris in the system. Although it is quite feasible for much larger particles to find way into the system, most of the debris will be below 5mm in diameter.

The system pumps shall be able to match / achieve one of the following condition given below:

A velocity in the system should be at least 10% higher than the design velocity, it will achieve when all the permanent system pump are in operation.

OR

A minimum velocity so as to remove particles up to 5mm as per BSRIA AGI / 2001 please find below minimum velocity to be maintained in the system with pipelines of different nominal size.

Nominal Pipe Size (mm)	Velocity (m/sec)	Flow Rate (L/s)
15	0.96	0.20
20	1.00	0.37
25	1.03	0.60
32	1.06	1.08
40	1.08	1.49
50	1.11	2.45
65	1.15	4.25
80	1.17	4.98
100	1.21	10.47
125	1.24	16.41
150	1.26	23.98
200	1.31	45.00
250	1.35	73.00
300	1.37	107.00

Note: - The system will have different pipeline but the above mentioned velocity should be achieved in the larger pipe size of the system.

- Flow reading must be taken at every available branch and riser measuring station to ensure the correct velocities are being achieved.

- If the pumps cannot match / achieved these parameters the system at the same time it will necessary to manipulate the system by closing certain section to force the pumps total flow through the open section of the system thus achieving the required flow velocity. The closed section will be then be opened and then the open section will be closed so the required velocities will have been achieved across the system.

Note: - The opening and closing must be carried out in this order to ensure no prolonged "Close Head" is affected on the pumps.

- Carryout filling, draining & circulating until the water is visibly clear.
- During the dynamic flushing all strainer that have flow through them must be checked and cleaned regularly until no more deposits are found in them.
- Temporary filters to be checked and cleaned regularly during dynamic flushing, on completion of dynamic flushing all must be isolated before chemical cleaning.
- The water treatment third party - will confirm acceptance of water quality, which shall be as per parameters mentioned below or is the same quality as the water being filled into the system, whichever is of the "Highest" quality.

PARAMETERS	VALUE (PPM)
Ph	7.5 - 8.5
Conductivity (µ Siemens / cm)	Max 800
TDS (ppm)	Max 400
Chlorides (ppm)	Max 200

Chemical Cleaning:

Prior to start-up of chemical cleaning, close all drain valves which were opened during dynamic flushing.

- Dose required quantities of cleaning agent (as suggested by chemical supplier) using temporary tank / pump system or manual dosing pot. The chemical B-12 @ 1 - 1.5 kg / m3 of system volume and should be circulated 24 hrs and maximum of 72 hours.
- The pump are switched on and will continue for a minimum period 24 hours until the recorded dissolved iron level have plateau.
- Continue circulation till 2 consecutive sample taken at an interval of 2 hours give same dissolved iron value.
- When dissolved iron level reaches a constant value clear the system of contaminated water by carrying out the filling & draining procedure stated in step B until the water sample take from a minimum of 2 separate drain point on the system show the water per parameters as mention below or is the same quality as the water being filled into the system, whichever is of the "Highest" quality.
- Flushed water can be disposed out to the storm water drain at the site subject to compliance with the norms set by municipality for disposal of water, otherwise it may be taken away by tankers and disposed of in a suitable location.

PARAMETERS	VALUE (PPM)
Ph	7.5 - 8.5
Conductivity (µ Siemens / cm)	Max 800
TDS (ppm)	Max 400
Chlorides (ppm)	Max 200

Final Inhibition:

- When the correct water condition have been achieved with the system circulation pump, close all the drain point.
- Passivation and microbicide chemical shall be added at this point. Circulate the water for 4 hours. Corrosion inhibitor chemical 2910 at the rate of 3.4 kg / m3 of the system volume. Microbicide chemical 651 to be added @ 0.05 kg / m3 of system volume.
- Water sample has to be collected at the end of this stage and if found with dissolved iron level higher than the previous value (analysis to be done by the "approved water treatment specialist") flushing has to be carried out to make the water clean.
- Keep the system in circulation including all the equipment's for the minimum period of 24 hours.
- Water samples have to be collected from the designated areas and the "Water Treatment" Third Party confirm the corrosion inhibitor level (Nitrite - minimum 700 ppm)
- A final water analysis indicating all the required parameters shall be submitted by the water treatment third party.

PARAMETERS	VALUE (PPM)
Ph	9.0 - 10.5
Conductivity (µ Siemens / cm)	Max 3000
TDS (ppm)	Max 2000
Dissolved Iron (ppm as Fe)	Max 0.5
Chloride (ppm)	Max 200
Nitrite (ppm) chem. 2910	Max 700 - 1300

Note:- After addition of final treatment chemical, the system must be left full and completely without any stagnancy.

Biological Control:

Chilled water system is an ideal breeding ground of bacterial and other micro-organism and it is necessary to control biological growth in the system. Supplier recommendation entail shock dossing of biocide chemical chem. 651 @ 0.05 kg/m3, the product is closed into the system using the manual dosing pot and is closed once every three months in order to control the growth of micro-organism, therefore, it is very important that residual level are contantly monitored and maintained.

Re-instatement of Plant Items & Back Flushing:

- When the correct water conditions have been achieved with the inhibition reinstatement and back flushing of all plant items (Coils, Heat exchanger, etc.) can begin.
- Ensure constant make up is supplied.
- Close the by pass.
- Open the flow isolation valve ensuring the return DRV is still fully closed.
- Slowly open the drain cock and let water flow into the drain or container until it visibly clear.
- Close the drain cock.
- Close the flow isolation valve.
- Open the return DRV.
- Slowly open the drain cock and let water flow into the drain or container until it visibly clear.
- Close the drain cock.
- Close all the valve serving the plant items, Remover the strainer (where applicable) clean and replaced.
- Open both the flow and return valve ensuring the flushing by-pass is fully closed.
- Continue these step with every previously isolated plant item on the system.

Note:- After reinstatement of all the plant items, the level of inhibitors must be re-checked and re-dosed as necessary.

BRIEF DESCRIPTION OF FLUSHING PROCEDURE

Water Filling

Potable water will be filled from a high point in the chilled water line preferably in the AHU room or downstream of the drain point. The filling point position is critical and care must be taken so as to ensure that fresh water make up water is not drained immediately after filling.

Source of Water

Existing potable water supply available in the station will be used. Otherwise, water will be supplied from tankers. And it would be compensated against the total system volume.

Circulation of Water

Water will be circulated with the help of the system pumps, during circulation, care should be taken that water temperature does not rise to a unsafe limit for pump. In such case, either the circulation should be temporary stopped; otherwise water should be partially drained and refilled with freshwater.

Drainage of Water

Water will be drained from the low point in the system. The water can be drained into the floor drain line, it can be also collected in a small tank and pump out to soak away ground outside the building. Third party (Specialist in water treatment) will guide whether the quality of water is suitable for drainage into sewer system / storm water system or for land pump system drainage, if it is not possible to drain into these system, then the drained water will be collected in a tank and will have to be taken out of station premises for disposal by tankers to comply with the local drainage practices.

Chemical Filling

The chemical will be filled into the system through the manual dosing pot installed in the Heat Exchanger room of temporary tank.

Bypass the Vital Equipment

Bypass line is provided for every AHUs and FCUs. The main inlet and outlet valves of cooling coil will be closed. Bypass valve will be opened. Wherever bypass line is not provided, The supply and return water pipelines will be disconnected from the unit and connected to each other with a temporary hose or pipe.

Air Vents

The air vent are provided at selected high point and will be used for air entry and exit during drainage and filling operations.

Water will not be circulated through the Cooling Coil and Plate Heat Exchangers until the **pipes are clean** and the quality of water is reasonably good.