Cleaning heat exchangers with High and Ultra high pressure water

Contents

1. Introduction

High pressure water has been used in the Chemical and Petrochemical industries as a cleaning agent for many, many years. One of the most important applications is the cleaning of heat exchangers and Hammelmann have been at the forefront in forcing through the change to automatic operation. As early as 1977 the semiautomatic “Pipemaster” system was in use incorporating multiple lance arrangements cleaning up to 5 exchanger tubes simultaneously. Today there is a wide range of High Pressure systems available to carry out heat exchanger maintenance.

In most cases tube bundles and shells are removed for maintenance and transported to a dedicated cleaning bay where they are cleaned both internally and externally by semiautomatic units. Most of the work involves cleaning Heat exchanger bundles, Condenser bundles, Cooling tower bundles, Evaporator bundles and Heat exchanger shells. The energy required to effect the cleaning process is largely dictated by the contamination (deposits) to be removed. The following table indicates various pressure and flow rate requirements:-

Petrochemical Industry		**Refineries**	
Contamination: solvents synthetic rubber soft polymers latex	Contamination: plastics pharmaceuticals (petroleum derivatives) processed foods (petroleum derivatives)	Contamination: crude oil viscose petroleum oil tar asphalt	Contamination: petrol diesel oil fuel oil petroleum coke
Operating pressure: from 800 bar upwards Flow rate: 180 l/min.	Operating pressure: up to 3000 bar Flow rate: 30 l/min.	Operating pressure: 600 to 800 bar Flow rate: 180 to 300 l/min.	Operating pressure: 800 to 900 bar Flow rate: 180 to 200 l/min.

Tube bundle sizes are designated as follows:

Standard bundle	**Large bundle**	**Very large bundle** (Not removable)
Diameter: 0.5 to 1,2 m	Diameter: 1,8 m	Length: 12 m
Length: 7 to 8 m	Length: up to 10 m	Weight: 300 tonne
No. of tubes: up to 1200	Weight: max. 25 tonne	No. of tubes: 10000

2. Extracting and refitting heat exchanger tube bundles

The Hammelmann bundle extractor is suspended from a suitable crane and positioned horizontally in front of the heat exchanger housing mounting flange by means of a balancing cylinder. A rigid connection is made between the housing and the extractor enabling the bundle to be pulled out. The hydraulic system is powered by a pneumatic motor. The same method in reverse is employed to refit the cleaned bundle in the housing.

Technical data:

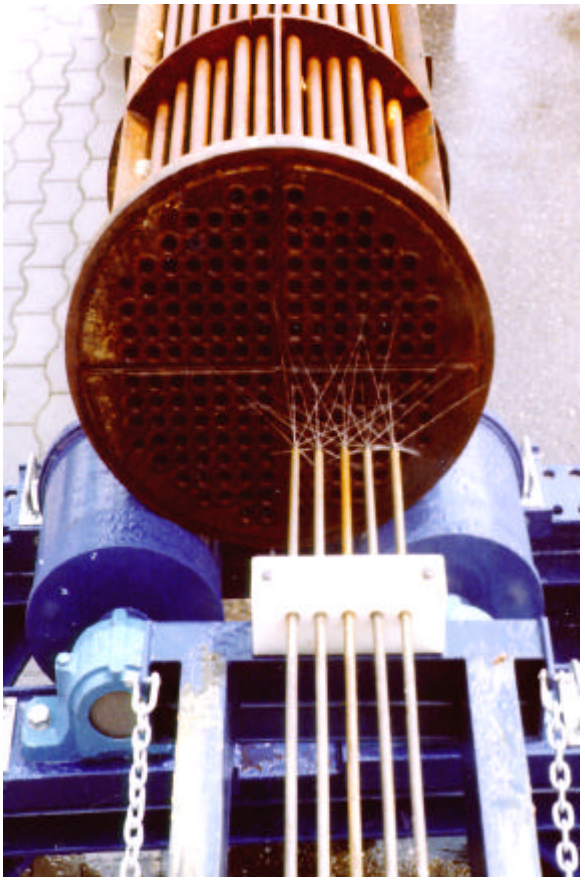
Dead weight: 6 tonnes or 10 tonnes
Bundle weight: 12 tonnes or 18 tonnes
Pulling/Pushing force at bundle: 120 to 300 kN
Max. bundle dimensions: Dia. 1,2m or 1,8m – Length 6,5m or 8,5m

3. Tube bundle cleaning

3.1. Internal cleaning

3.1.1. Semiautomatic cleaning units

The Hammelmann “Pipemaster” is a semiautomatic bundle cleaning unit that drives static or rotating rigid water blasting lances into the bundle tubes. The speed of lance advance/retraction is continuously adjustable between 0 and 0,5 m/sec. The number of lances up to a max. of 5 per unit is governed by the sizes of bundles normally cleaned but 1, 2 or 3 are the most popular choices. On multiple lance units the distance between lance centres is adjustable to suit the various pitch circle diameters of the tube bundles. The rotating lances are used for bundles where the contamination is particularly difficult to remove.



The bundle is placed on roller supports enabling the operator to rotate it into the required position. The lance carrier incorporates the lance advance/retraction system and the fine adjustment unit. The carrier is mounted on a traversing mechanism which in turn is mounted on a scissor type jack up access platform. The access platform can be outfitted with a fully glazed, totally enclosed, ventilated operator's cabin if required incorporating all the unit controls.

3.1.2. Manual internal cleaning

Manual cleaning can be carried out both on in situ or on removed tube bundles. Either rigid or flexible water blasting lances can be used.

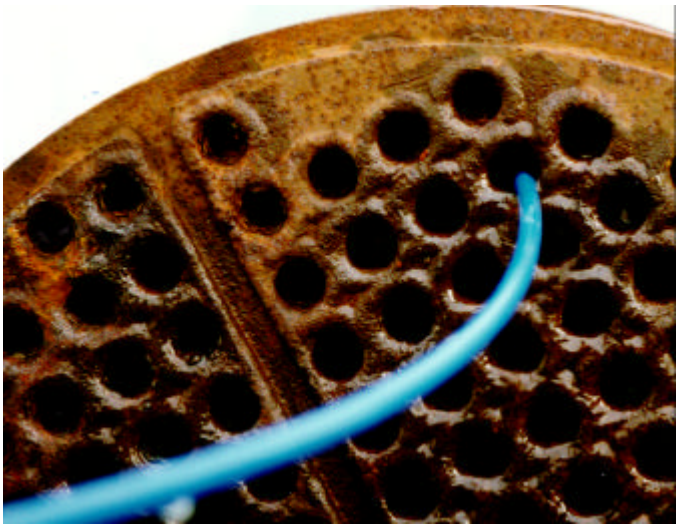
3.1.2.1 Rigid lancing

Manual lancing is predominately carried out with rigid lances. They are available in a number of diameters to suit various flow rates and pressures. Generally the max. length is limited to 6 m to prevent flexing but this does not present a problem as the majority of bundles can be cleaned from both ends. The max. pressure lance available is designed for 3000 bar operation. The lance is normally attached to either a dry shut off, mechanical bypass or electrical bypass (at the pump) water blasting gun where the gun trigger controls the pressure ON/OFF functions. Ultra High Pressure lance (2000 to 3000 bar) performance can be enhanced by attaching it to an electrical bypass, pneumatically driven, rotating blasting gun.

If a rigid lance is connected directly to a hose rather then to a blasting gun the pressure ON/OFF functions are controlled either by a foot operated bypass valve or a foot operated switch connected to the pump bypass valve.

3.1.2.2 Flexible lancing

If for any reason rigid lances cannot be employed, eg. limited access to the bundle or the bundle has U bends then flexible lances are used. They are available in lengths up to 10 m and operating pressures up to 1000 bar and incorporate safety fittings. Flexible lances are marked with a ring 50 cm back from the blasting nozzle to indicate to the operator when he is pulling the lance out of the tube that the high pressure water/pump should be bypassed.



An even higher degree of safe operation can be achieved by attaching a lance deployment device to the exchanger/bundle end flange. The lance is fed into the tube via the device which effectively prevents "blow back" in the event of a blocked tube causing high pressure build up. The device can also be applied to rigid lances and a version is available for pipe cleaning.

3.2. External cleaning

3.2.1. Semiautomatic cleaning units

The "Pipemaster" for cleaning the external surfaces of bundle tubes is another purpose designed unit. The tube bundle is placed on roller supports that are mounted within the base frame of the unit, The rollers are hydraulically powered to rotate the bundle after each cleaning pass of the blasting head.
The head is mounted on a gantry that travels the length of the bundle and back at a speed set by the operator. The head can also be swivelled, traversed, raised and lowered. All functions are controlled from a single hydraulic console. Optional extras such as low loader, road going frame and operator's cabin are also available.

Technical data: (Stationary version)

Length: 10m
Weight: 5 tonnes
Bundle weight: 25 tonnes
Max. bundle size: 1,8m dia., 8m long

3.2.2. Manual external cleaning

Manual cleaning is carried out with blasting guns. These can be fitted with pin or fan jets to clean between the individual tubes or with self driven rotorjets. Rotorjets or rotating blasting guns are particularly useful for cleaning bundle end plates and shells.

2. High and Ultra high pressure systems

4.1 High and Ultra high pressure pumps

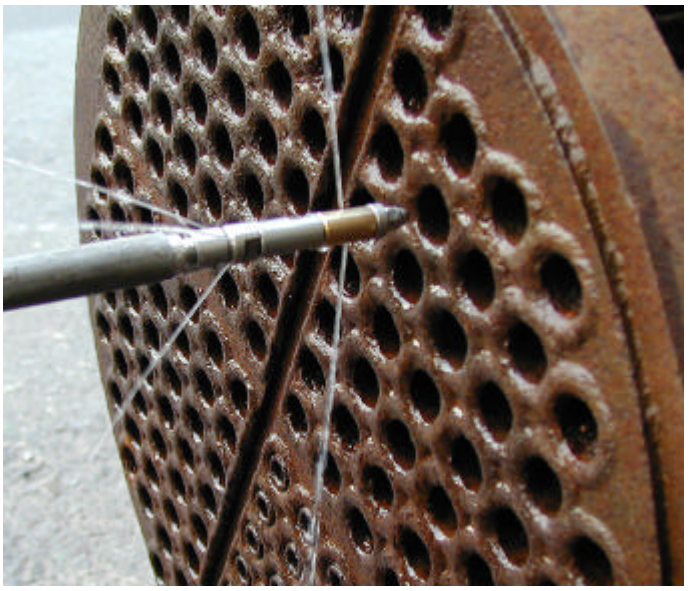
Semiautomatic cleaning systems often operate under continuous duty conditions with very frequent and rapid bypass switching cycles. The pumps therefore must be extremely robust. Hammelmann pumps are available at power ratings from 110 to 400 kW for single or multiple lancing at pressures up to 3000 bar and flow rates up to 300 l/min. Hot water pump units are also available.

Hammelmann three or five cylinder pumps are vertically mounted which offers certain advantages over traditional horizontal pumps. The cross head and plunger weights are neutralised within the sealing system effectively reducing wear on all oscillating parts. It also enables construction of very compact units.
Hammelmann crank sections are designed employing the Finite Element Method of calculation to ensure long working life under continuous duty. The dynamic plunger seal assembly produces pressures up to 3000 bar.
For the many varied applications pumps are combined with systems to form self contained units. Our standard range includes stationary units with diesel or electric drive and mobile units for either on site or public road use.

4.2. Cleaning nozzles

There is a wide range of cleaning nozzles available to suit all types of heat exchanger and all sorts of contamination.

4.2.1. Turbojets



Turbojets are available to operate at pressures up to 1500 bar. The nozzle body driven by the reaction force of the water jets rotates at speeds up to 2000 rpm eliminating the ‘striping’ effect caused by some rotating nozzles. Outside diameters range from 12 mm to 47 mm and are therefore suitable for tube i/d’s from 15 mm to 100 mm.

Turbojet water jets emit at right angles/tangentially which is ideal for removing thickly encrusted deposits from pre cleaned tubes.

Additional forward facing jets at various angles can be incorporated so that the Turbojet will blast through tube blockages.

The Turbojet can be driven forwards into the tube by fitting a static nozzle holder as an adapter between it and the flexible lance hose. The reaction force of three jets angled backwards drives the Turbojet into the tube and simultaneously flushes out all the removed dirt. This prevents clogging and lance jamming enabling even longer tube lengths to be cleaned.

4.2.2. Push and Pull nozzles

Push and Pull nozzles are manufactured from hardened, non rusting stainless steel and can be operated at pressures up to 3000 bar. The outside diameters range from 8 mm to 27 mm and are therefore suitable for tube i/d's from 12 mm to 80 mm.

Push nozzles have backward facing angled jets and can be used on both rigid and flexible lances. Broaching push nozzles have an additional forward facing central jet for clearing blocked tubes. The deposits adhering to the tube wall are cut away by two or more radial jets. Tubes containing softer deposits are generally cleaned with Push nozzles where the water flow emits from up to ten radially arranged nozzle bores.

Pull nozzles with forward facing angled jets are used on rigid lances to clean partially or fully blocked tubes. Broaching pull nozzles with an additional forward facing central jet are also available.

For extreme cases nozzles are available with a front mounted chisel to effect water assisted mechanical removal of hard deposits.

4.2.3. Rotorjets

Hammelmann Rotorjets combine the concentrated cleaning power of round jets with the high area coverage of fan jets. A wide range of Rotorjets with a choice of nozzle inserts and formats in all pressure ranges, shapes and sizes is available to cover just about every surface cleaning/stripping situation imaginable.

There is even a special tube bundle external cleaning Rotorjet with a triple nozzle arrangement producing three extremely coherent high power jets. Other models are available for blasting tight angled structural members such T beams, U profiles etc. Used in conjunction with High and Ultra high pressure blasting guns, Rotorjets are the ultimate surface cleaning/preparation tools for use in the Chemical and Petrochemical industries.