

THERMAL CLEANING OF HEAT EXCHANGERS, AN IMPROVED TOTAL CARE SERVICE FOR AN OPTIMAL CLEANING

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ABSTRACT

The Thermo-Clean group has developed an improved way of removing fouling from heat exchangers using thermal cleaning. This resulted in a safe and very effective cleaning technology with astonishing results in operational lifespan and energy savings.

By the use of controlled heat, a very thorough cleaning takes place, even in places where the typical high pressure cleaning has no access to. After thermal cleaning, heat exchangers will practically come up to their original specs. The result: perfect heat transfer, longer use in production and no residue mixing with your products.

Furthermore, thermal cleaning is fast, so short delivery times are possible during shutdowns. After all, better cleaning means less cleaning. As a result, the time between expensive shutdown cleanings can be extended.

INTRODUCTION

The Thermo-Clean Group has been very active in the thermal cleaning of heat exchangers for 25 years now. In the early years, only heat exchangers with specific fouling could be cleaned properly. Any type of fouling that would create an exothermic reaction during the thermal process made it difficult to guarantee safe and controlled cleaning. Heat exchangers could be deformed during the gasification process due to inadequate temperature control.

Thermo-Clean developed a completely new thermal cleaning system as well as special software and tooling. This now enables Thermo-Clean to completely remove all kinds of organic fouling, and even combinations of organic and inorganic fouling, in a safe and environmentally friendly way with no hazardous waste or huge amounts of wastewater.

In comparison to other cleaning methods, our unique thermal cleaning process delivers superior benefits. Thanks to the controlled heat, the cleaning

process is extremely thorough. This means we are able to remove fouling from inside the tubes, around the tubes, between the tubes and shell (even fixed shells), and inside tubes with static mixers, all at the same time.

Together with our 'Total Care Service' approach we will ensure the optimal conditions from the start till the end of each cleaning process.

WHAT IS THERMAL CLEANING?

Introduction to the thermal cleaning technique

The pyrolysis process. Pyrolysis is the thermal decomposition of organic materials in an oxygen-poor environment (Fig. 1).

At a temperature below 450°C (842°F), organic materials are converted into a homogeneous residue ready for further controlled processing.

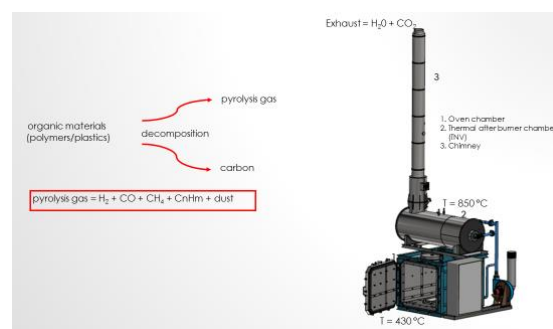


Fig. 1. The pyrolysis process.

At such high temperatures, higher hydrocarbons are decomposed into components with a much lower molecular mass, resulting in pyrolysis gases (ethane, ethene, propane, propylene), pyrolysis oil (which contains aromatic components), and a carbon-rich residue.

The pyrolysis gas and oil are transformed into carbon dioxide and vapor due to partial oxidation. This phase is exothermic, and 40% of the energy released is reused to decompose the organic material.

Aside from steady heating and cooling, a very important factor in the process is maintaining a constant temperature to prevent damage to the parts being cleaned.

Advantages of the thermal cleaning technique.

Thermal cleaning reduces 1 kilogram of fouling to only 50 grams of dust, which is easy to remove. Moreover - and this is one of the biggest advantages of this cleaning method - the controlled heat reaches all areas of the contaminated component, meaning that pyrolysis occurs everywhere in the component being cleaned.

Because the heat can reach everywhere, thermal cleaning is extremely well-suited to heat exchangers. It causes fouling in extremely inaccessible places to decompose into dust, which can then be removed easily using simple techniques¹. This is impossible if for example only high-pressure water cleaning is used.

After thermal cleaning, your heat exchanger will be returned close to its original performance level. This results in perfect heat transfer, longer production life and no residue mixing with your products. In short: better performance at a lower cost.

General functioning of a pyrolysis oven. A pyrolysis oven (Fig. 2) consists of an operating chamber 1m³ to 100m³ in size, depending on the type. The standard maximum dimensions of today's ovens are 10m x 3m x 2.5m, but even larger dimensions are also possible.

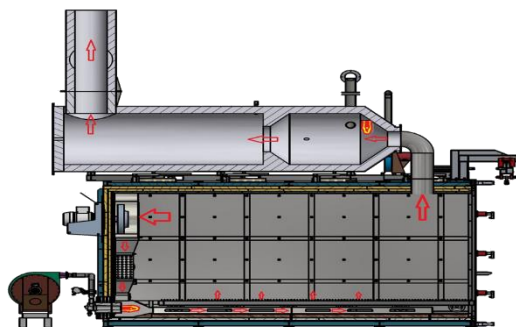


Fig. 2. Working principle of a pyrolysis oven.

The parts to be cleaned are put on a loading cart that is brought into the oven chamber. After closing, the oven chamber is made inert by lowering the oxygen level to 8%. The temperature is then slowly increased to as high as 450°C (842°F), depending on the character of the objects and the nature and amount of fouling.

When the temperature required for gasification is reached, the internal ventilation system causes the gases released to flow to the afterburner chamber. Here, they are processed at high temperature (>850°C/1562°F) for at least 2 seconds, after which they are removed¹. This air current is sometimes used for heat recycling to recover part of the energy.

Because all organic components are gasified, only a residue consisting of pigments and inorganic fillers remains on the products treated. This is

generally 1-5% of the original fouling volume and can easily be removed by various techniques.

A COMPARISON**Traditional vs. thermal cleaning**

The level of cleanliness achieved by traditional cleaning methods for heat exchangers is often only visual. It may look clean enough to the operator and be used for many years, but after the cleaned heat exchanger is started up, the original performance is never gained back. But because there was no viable alternative, this has always been how fouled heat exchangers were cleaned.

Nevertheless, there are a number of very specific problems that everyone recognizes. High-pressure water cleaning causes deterioration of the surface and cannot reach all the fouling.

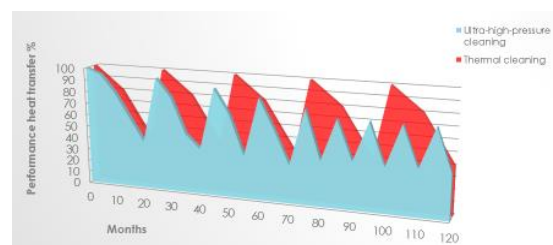


Fig. 4. Comparison of frequency of ultra-high-pressure water cleaning vs. thermal cleaning.

The remnants left behind mean that your exchanger has to be taken out of production to be cleaned again sooner and aside from the bill for high-pressure water cleaning, there is the secondary and often hidden cost of the high volumes of wastewater produced. (Table 1, Table 2, Fig. 4).

Table 1. Comparison ultra-high-pressure water cleaning vs. thermal cleaning

	Ultra-high-pressure water cleaning	Thermal + high-pressure after-cleaning
Typical cleaning results	65-95%	95-100%
Water consumption	50,000-500,000 L	Max. 10,000 L
Risk level	High risk of injury (manual)	Very low risk of injury
Time	4-16 hours, sometimes 1-2 weeks	12-100 hours
Capacity	1 piece	Possible to clean several pieces simultaneously

Effective for all types of fouling	Not effective for many contaminants (e.g., calcium, hardened plastics are difficult)	Yes. Almost all (organic) contaminants can be removed
Waste (water & original fouling)	100% of water used + 100% fouling = chemical waste	1% Is collected.

Chemical cleaning can sometimes take a long time to dissolve the fouling, which delays the availability of the tube bundle. On the other hand, thermal cleaning is very effective and reaches every spot. The results prove that a degree of cleanliness of almost 100% can be reached, which results in longer operating times between cleanings and therefore cost savings (Table 1, Table 2, Fig. 4).

Cost comparison

Table 2. Cost comparison

	HP water cleaning	Thermal + HP after-cleaning
Hourly rate	€€€	€€€€
Water	€€€	€
Wastewater	€€€€€	€
Location	€€	-
Safety engin. client	€	-
Lifting costs	€€	€
Transportation costs	€	€€€

THERMO-CLEAN'S TOTAL CARE SERVICE

Our process

At Thermo-Clean we do more than cleaning alone. With our total care service approach we will unburden our customers completely. Besides decommissioning and recommissioning the heat exchanger on site, we arrange everything. This is how our cleaning process works.

ⁱ The remaining dust can easily be removed using various techniques (e.g. high-pressure water cleaning or ultrasonic cleaning) and results in only 1,000-2,000 liters of water contaminated with dust that is easy to filter and reuse.

ⁱⁱ If the fouling contains sulphur and/or halogens, the gases need to be scrubbed before entering the atmosphere. The

1. Our customer dismount and prepares the heat exchanger to be transported.
2. Thermo-Clean arranges the appropriate and safe transportation to our nearest cleaning facility.
3. Thermo-Clean disassemble the heads and floating heads, among other components. And then take the heat exchanger from its casing. Is it stuck? Then, a first primary cleaning is needed in order to get it out.
4. The thermal cleaning itself is performed in specifically in house developed pyrolysis ovens, and according to a cleaning procedure that is customised to the specific bundle. After that, the heat exchanger will be cleaned with high- pressure water jetting.
5. Then all the other specified maintenance works need to be done. This means that we can refinish the casing, perform an Eddy Current testing or even repair or replace damaged tubes.
6. Reassembling of all parts.
7. Several tests are done to verify that your heat exchanger is 100% operational and to detect any potential leakage.
8. The heat exchanger is carefully prepared for shipment to return to site.
9. The clean heat exchanger can be installed for immediate use.

CONCLUSION

The result of thermal cleaning is that your heat exchanger is as good as new after cleaning and has again a maximum output and an extended service life. The Total Care Service approach is a turnkey solution that organizes, performs and checks everything with the results of a sustainable, safe and optimized Total Cost of Ownership.

NOMENCLATURE

- C Celsius scale, centigrade scale, temperature scale, °C
 F Fahrenheit scale, temperature scale, °F
 L Litre, unit of volume, L, l
 m Meter, unit of length in metric system, m
 mm Millimeter, unit of length in metric system, mm
 m³ cubic meter, unit of volume, m³

permitted emissions are regulated by local authorities and can vary between countries.