World leaders for Inspection and Training to the Food and Drinks Industries

THE DETECTION OF DEFECTS IN PLATE AND TUBULAR HEAT EXCHANGERS

History

There is a requirement for reliable methods to assess the integrity of plate and tubular type heat exchangers in the food industry. Cracks, pinholes, and corrosion which could lead to contamination of the product with concomitant ingress of bacteria or chemical coolants leading to possible reduced shelf life, rejection of the product, or at worst food poisoning. Environmental Health Departments, Retail organisations and other authorities around the world require testing to be carried out on a regular basis to reduce the risk of product contamination from bacteria and/or harmful chemicals caused by cracks within the heat exchange elements. It is the responsibility of the processor to comply with 'Due Diligence' procedure.

Pasteuriser, heater, and/or cooler heat exchangers in the dairy, liquid food, beverage, and Pharmaceutical industries include a product path, which may contain milk, juice, beverage or other liquid products placed for heat treatment. A heater, cooler, and/or un-pasteurised product medium is passed around an adjacent circuit in close heat exchange relationship with the product path via a number of heat exchange plates or pipes. Industrial heat exchangers including off-shore, marine, nuclear, chemical, medical, demin-water etc can be PHEs, Tubular, or Shell and Tube type heat exchangers.

From time to time, **defects** develop between the product and the heater, cooler path that may cause cross contamination of the finished product. Such leaks can be very costly, not only because the contaminated product may be discarded, but also the product may have been consumed before the laboratory test results have identified such contamination. This may be in the form of bacterial or chemical **contamination**.

In the past, inspections have been carried out using chemical dyes, pressure testing with gas or water, helium gas testing, EDA testing (originally developed by Mike Bowling), DFD testing (originally developed by Mike Bowling), None pressurised dye testing which involved opening the individual elements to enable the test procedure. All of these methods require the movement of large items of equipment, normally 2 men and a van. They are all volume dependant (p.p.m.), for example, one side of the heat exchanger is filled with water, gas or chemicals, then the other side has the detection equipment which detects movement of donor side into recipient side through a defect in the heat exchanger. Therefore if we take a small heat exchanger and compare the results to a large heat exchanger test, it is like dropping a grain of salt into a small cup with a conductivity probe inside, then trying the same check by dropping the grain into a large pool, it will not be detected.

After many years of experience in the NDE business, Managing Director Mike Bowling who qualified at Cambridge in Ultrasonics, Radiology, MPI/LPI, Weld and casting engineering, Mike decided to challenge this methodology. Having spent considerable time developing various inspection techniques in the aerospace and nuclear industries, this was a good background for the challenge.

In the early 1990s Mike Bowling developed Testex and in 2000 realised the limitations of using the volume dependant test methodology, so decided to explore a completely different system capable of checking large and small units.

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So, the task was to produce an instrument that could scan the internal surfaces of large and small heat exchangers, being robust, simple to operate, and could also determine the size of the defect with the use of very sensitive ultrasonic transducers. This was the birth of an instrument technology now known as Hexteq.

HEXTEQ

The method is able to detect and show the size of internal defects electronically, without the assistance of any chemicals or gases. The system is able to detect defects by connecting the heat exchanger to mains water supply via EIT International designed adaptors, filling both sides of the heat exchanger with water from the mains supply, pressurising one side only (donor side) to ~ 3 bar, also using the mains supply, connecting a sensor transmitter to the recipient side at atmospheric pressure, which starts to transmit and log data from the internal surface of the heat exchanger. Then switching the control unit on, after receiving GPS connection, then switching on the HP unit, all 3 units are connected to each other via radio telemetry. Once the system is put into test mode, all recording starts, the test takes 5 minutes. If the heat exchanger has a defect, it is recorded and sized by detecting the flow rate of liquid in microlitres, through any defects present, a graphical display is then downloaded onto pc for certificate generation.

The sensitivity has been checked against standard laser drilled holes in an approved test plate made from stainless steel, verified through a scanning electron microscope. This test equipment was then independently validated at Bath University, which showed the comparison between the Hexteq results printed on graph display and the results through calibrated holes of just a few microns in size. These tests were conducted at many different pressure differentials and many varying hole sizes. The tests also showed that holes < 20 microns did not leak when the test pressure differentials were below 1 bar, therefore it is now possible to predict when the heat exchanger is going to fail, thus allowing the processor time to maintain the units properly.

Table taken from Bath University report: (Sample)

Reference No	Hole Diameter (micron)	Pressure in Bar	Leakage micro litre	Hexteq diameter calculation
00258	25	3	10.19	25.5
00259	25	3	10.26	25.6

EIT International have now produced a defect limitation standard for the examination of heat exchangers in the food processing industry. Up until now there has been no standard, as the technology in the marketplace could not determine the size of the defects, or the volume of contaminants leaking into the product side of the heat exchanger.

It is a very expensive exercise to replace elements within a heat exchanger, and very important to correctly assess the condition of these heat exchangers by using technology able to accurately determine the size of the defect/s.

Rejectable defects are reported on an interim report sheet and the client is advised to replace the plates concerned. Recordable defects are also reported on the interim report sheet and the client is advised to check the condition of this unit on a more regular basis and report any growth of defect (condition monitoring)
A final test certificate is then produced from head office and sent to the client.

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