

MATTHEWS INTEGRITY HUB

FAILURE BRIEFING

BUCKLING FAILURE OF STEAM 'KETTLE' VESSEL

CODE NON-COMPLIANCE

THE ARRANGEMENT

The top photo shows steam heated steam 'kettle' vessels used to make jam and similar foods. The double-skin extends halfway up the vessels. Steam at 1.5 bar is supplied to the outer annulus and heats the food inside. A replacement stainless steel vessel as shown in the middle photo was purchased second-hand to use for the same purpose.

THE FAILURE

The replacement vessel had no code details or nameplate so was subjected to a hydrotest at 2.3 bar which it passed. On connecting it to the 1.5 bar steam it was brought up to operating temperature in a few minutes with 100kg of jam mix inside. There was then a loud bang and the internal annulus buckled ('imploded') ejecting the hot contents around the room.

THE CONSEQUENCES

People working nearby were splattered with hot jam and received some scalding injuries. Fortunately the steam envelope was not breached to no steam escaped ;this would have caused serious injury even at an operating pressure of only 1.5 bar.

WHAT WAS THE CAUSE?

How could the vessel have failed at 1.5 bar if it had previously passed a hydrotest at 2.3 bar? It might be natural to think that the temperature might have had some effect. See next page for : **Failure Diagnosis and Lessons learned**



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The existing steam 'kettle' vessels



The replacement vessel installed



The replacement vessel after buckling failure of the internal annulus

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FAILURE BRIEFINGS

We think it is important in the asset integrity industry to **SHARE INFORMATION** on equipment accidents and failures. This is the main way in which people learn how failures can be prevented and that the same mistakes do not happen again and again.

Most causes of failure are well known and can be prevented by learning from things that have happened in the past

WE INVITE YOU TO PARTICIPATE

The more failure briefings we can show on these pages the better the chance of failures not repeating themselves unnecessarily. If you want to pass on details of failures you've experienced we will be pleased to edit them into our failure briefing format so they can be of greatest benefit to others in the plant integrity community.



HEAD OFFICE

CODE NON-COMPLIANCE : LESSONS LEARNED

THE DIAGNOSIS

The vessel had no code nameplate and ,on observation, the design is not that of a steam heated vessel. The annulus continues fully to the top of the vessel (unlike the existing kettle vessels) and the outer shell contains fillet-welded lap joints,; not a feature of most steam vessels. The vessel also has several blanked-off connections.

This design is not suitable for use as a steam-heated vessel. Its most likely origin is as a vessel designed for cooling the internal contents using a liquid cooling coil inside the annulus ,such as an ice-cream cooler. The annulus would therefore not be pressurised.

Stainless steel does not weaken significantly at 127 degC (the saturation temperature of steam at 1.5barG) so this was not an issue in this failure.



Buckling is an unpredictable failure mode so when the hydrotest was carried out then the buckling would have been imminent. When connected to the steam then even mild steam-hammer from the steam system (condensate

lodged in the feed pipe) would be sufficient to cause the catastrophic buckling to occur.

LESSONS LEARNED :How not to let it happen again.

Vessels used for steam service should meet recognisable design codes for boilers or unfired vessels. If there is no nameplate of documentation then it is not safe to use without risk.

Pressure tests where a vessel is under external (buckling) pressure should be held for long enough to enable failure to occur if it is going to.

Whoever witnessed the hydrotest did not make sufficient enquiries to determine the planned use of the vessel OR they didn't know the difference between a steam heated vessel and a cooling vessel. Owner-users should choose competent persons to witness tests on their behalf .

Matthews Integrity Notes: HEAD OFFICE is OPEN EVERY DAY....0730-2200 Monday-Sunday...That's correct, all week, including holidays.

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