BOOSTERS - TOO HOT TO HANDLE

by Ian Speer

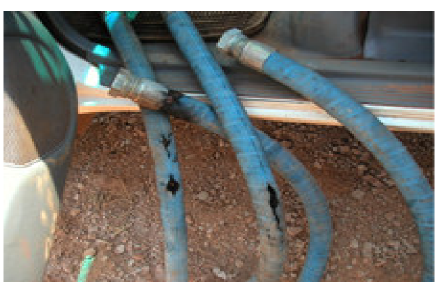
I was wrong!

Well, as long as my wife doesn't hear me make that admission I'll be okay.

I was wrong in that I always thought that there would have to be a measurable quantity of oil being passed out of the primary compressors to a booster for a fire to take hold and damage a machine.

Last edition's remarks generated quite a bit of response and since publication I have been involved in investigating several fires, as well as testing a number of different types of boosters and compressors.

During the testing of one booster at full load, a fire occurred. Fortunately, as we had taken a number of precautions, no damage was done to the booster. The important thing about this fire was that it started under carefully controlled conditions and, thus, we are now better able to understand the nature of the problem as well as the best way to prevent further fires.



Hoses removed from M41B-870 after the first fire burned through from the inside.

In short, the unit was a Hurricane M41B-870, some eight years old, which had been overhauled several months ago. It had been functioning correctly when, without warning, it suffered an internal fire in the scrubber resulting in the inlet hoses to each cylinder burning through from the inside (Picture 1). There was no obvious reason for this event and I was asked to go to site and investigate the problem.

We initially checked out both of the primary compressors and aside from a couple of minor adjustments to the regulation systems, and noting that the separator on the auxiliary was passing a very small amount of oil, nothing abnormal was found. A replacement separator was ordered and when it arrived it did not fit, so the units were run with the oil carryover to test the booster.

The booster required new valves, rings, cylinders, inlet hoses and a mesh filter for the scrubber tank. The remainder of the system was cleaned, the new parts fitted, and the booster was test run to ensure there were no mechanical problems.

3. The throttle valve and coupling, as well as the inlet to the flowmeter that was at the seat of the fire. There was no significant rise in the temperature at the inlet to the throttle valve at the right of the picture; however, the coupling reached 482°F.

At this point the two primary compressors were connected to the booster and the booster outlet hose was run across some 15 m to a utility where the flowmeter was securely mounted.

All three units were started and warmed up (at 42_C not much warming up required!).

The booster test proceeded normally right up to 850 psig discharge pressure and we monitored all gauges on the booster as well as on the test equipment. We also had a hand-held infra red thermometer on site to make individual measurements as required.

The booster itself performed normally, with all pressures and temperatures within the makers specifications. We did note that the temperature of the air being discharged from the after cooler was higher than we expected and we monitored the air temperature at the flowmeter over a period of time during which it rose to 252_F (122_C) which is at the limit for the Aeroquip GH195 hose in use on most rigs. The published limit for GH195 is 121_C, according to my most-recent catalogue.

At this point in the testing, the air temperature gauge on the booster measuring the discharge air temperature from the booster valves was a little over 300_F, well below the shutdown temperature for these units.

In view of the still-rising temperature and hose limitations, testing was discontinued and the flowmeter throttle valve opened to dump the air from the pressurised system and allow things to cool down.

At this point, the trace of oil in the air being discharged from the flowmeter ignited inside the flowmeter, with a large stream of black smoke emanating from the flowmeter. The other people on site stationed near the shutdowns, immediately shut down all machines and the fire went out.

The fire lasted for about two seconds and the heavy steel coupling (Picture 3) turned purple in this time as well as blistering the paint on the flowmeter and destroying my test gauge.

4. Film of oil on the interior of the scrubber after the incident. During testing, the fact that this was still in place is testament to the value of well-placed observers and good emergency shutdowns.

When the machines were shutdown the fire flashed back up inside the hoses through the booster bypass, into the scrubber (Picture 4), up through the mesh (Picture 5) and into the cylinders.

5. Passage of fire up through the new scrubber mesh element into the cylinders.

I was measuring the temperature of the coupling (482_F) and the main hose (240_F) to determine where the seat of the fire was and I was very pleased when the observers shut the system down!

The booster scrubber was then dismantled (see picture 2) and there was only a suggestion of a film of oil inside the inlet from the auxiliary compressor, which, in the past would not have concerned me as the carryover was very small. A new separator was fitted to replace the unit in the auxiliary compressor that was passing oil and the whole set-up successfully retested.

How does this relate to the other failures we have seen in the field and what can we learn from this episode as I for one do not want a repeat?

1. Any oil carryover has the potential to fuel a fire.
2. While all boosters have high discharge air temperature shutdowns to protect their valves they DO NOT HAVE SHUTDOWNS AFTER THE AFTERCOOLER TO PROTECT THE CREWS AND HOSES. Fitting such shutdowns should be considered as a priority.
3. Aftercoolers have a finite life and it is important that the air being discharged from the booster is cool enough to prevent spontaneous combustion as it passes through the systems on the rig.
4. Are the current check valves fitted to some boosters capable of operating as flash-back preventers similar to the units now required on oxy-acetylene welding equipment?

6. Shot of the oil carryover visible as a faint blue mist during another testing. The level of carryover requires LESS than 1 litre of oil per week and can sustain fire.

Subsequent to testing this unit, I tested several Ariel boosters in the same general area and although one of these units was being fed quite a quantity of oil from a primary compressor with a failing separator, there were no incidents. The peak discharge temperature from the outlet of the aftercooler on one of the Ariels held at 900 psig for some time was 152_F (67_C). See the picture 6 of the test showing oil carry over which was much more than what was required to burn in the M41 in question.

Most manufacturers rate their after coolers as being capable of cooling to within a specified approach temperature (usually 40C_) to the prevailing ambient temperature. That is ambient plus 40C_ and as the aftercooler degrades it does not cool as well and we need to watch this and replace the unit when the air being discharged exceeds a safe level, which I would suggest would be 80-85_C at most.

This is a point requiring some discussion and input from booster manufacturers, cooler manufacturers, hose suppliers and lubricant suppliers would be most welcome.

As discussed previously, any degradation of the aftercooler, while not affecting the mechanical function of a booster, will almost certainly compromise safety once the discharged air exceeds the temperature rating of the hoses, not to mention the now demonstrated ability to start a fire within the system.

2. Inside the scrubber after the first incident the interior was dry with only carbon residue; however, there was oil in the inlet pipe from the primary compressors.

If you think about the conditions during the test when the fire occurred, it is clearly quite similar to what happens on a hot, dry day when a driller is on a deeper, dry hole and is holding 600-800 psig and lifts off bottom to ream back quickly to add another rod.

The fire starts at the hammer then flashes back up the rods and becomes established in the booster scrubber, where the flames are sucked into the booster cylinders, and the inlet hoses into the booster cylinders are burned from the inside out.

During the test, the combustion products were immediately evident as thick black smoke coming out of the meter. However, there would be far less warning if the rodline was connected and hence the fire would not be evident until it burns out through the system hoses.

I would be very interested to receive comments by whatever means from drillers who have experienced fires in their air systems as it is in all of our interests to eliminate this problem.

Picture 6 Shot of flowmeter showing oil carryover visible as a faint blue mist during other testing. This level of carryover requires LESS than 1 litre of oil per week and can sustain a fire.

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