COMPRESSOR CAPACITY TESTING

by Ian Speer

Nearly everyone reading this article will either own or operate one or more significant-sized air compressors. In most cases these will be multi-stage, oil flooded, high-pressure rotary screw compressors often feeding into a booster.

Over the working life of a large compressor the driving engine will probably be rebuilt several times. Likewise the compressor will be rebuilt from time to time. Both the engine and compressor will receive periodic oil changes and routine servicing. The engine will in addition receive regular tune ups or hot sets.

In this article we will look at the issues of deciding when to rebuild a unit so as to obtain the greatest service life while avoiding a catastrophic failure. Catastrophic failures, at best, involve expensive repairs which when complete result in a unit producing less than its rated output. At worst, the unit will be unrepairable and a replacement unit will be required.

We will also look at the possible effects of degradation of the control systems of a compressor on its output. To illustrate the effects of each type of problem we will look at actual test data to better understand possible gains and savings that may be achieved.

To decide on the best time to do a compressor rebuild we need to consider the ways that people currently use to assess their units and then to decide when to repair or rebuild.

1. After a significant mechanical failure.
2. When interstage pressure rises in a 2-stage compressor.
3. When oil sampling reveals the presence of abnormal amounts of wear metals.
4. When the unit starts to run hot and no faults are found in the cooling system.
5. When the operator notices a substantial loss of performance in his drilling tools which is not due to worn tools or down hole issues.
6. Rebuild at fixed intervals.

Each of these options will result in costs for the owner due to repairs being more costly and taking longer due to major component damage. The specific disadvantages of each option are detailed below.

- Loss of production due to unplanned downtime.
- Increased fuel consumption.
- Increased repair costs.
- Rebuilding before the unit has reached the end of its economic service life.

Items 1 to 4 are all a result of mechanical wear occurring and, if expensive repairs are to be avoided, the problems need to be detected prior to serious mechanical damage.

Items 4 and 5 can involve very large losses to the owner of the compressor in question.

Item 6 results in a fixed rebuild cost per hour of compressor operation however it will in all probability result in over servicing of the unit.

What is required is a method to identify wear and or loss of capacity accurately prior to significant mechanical damage or financial loss occurring. Early identification of problems also provides a real opportunity to better plan the repair work needed thus avoiding upsetting clients as well as expensive rush freight bills associated with in field change outs.

The other issue is slow degradation of the output of a compressor which can result from either mechanical wear within the compressor unit or alternatively deterioration of components in the control system. Such loss of capacity is hard to detect as it occurs slowly however it can amount to 30% of the compressors output.

Commonly, the fuel consumption of the compressor will remain unchanged as the loss of output compounding the losses. Higher consumable costs as the hammer and bit do not cut as effectively, unchanged fuel consumption, unchanged labour costs and reduced metres drilled per shift. Surely the worst of all possible worlds?

Accurate capacity testing will reveal many problems before they are found by the usual methods. It will also in many cases return the output of a compressor to what it should have be at a modest cost and thus provide an instant production increase.

The following sets of test results illustrate a range of problems, how they were detected, the course of action adopted and the outcome for the owner of the compressor in question.

Contractor #1

This contractor noticed that his output pressure from his booster had fallen off somewhat after a couple of years in the field and that his long-term metres per day had fallen off, reducing his profitability. He also noted that his booster was running hotter than it had in the past.

Suspecting worn booster valves or worse, he booked the unit in for a booster rebuild. The compressor and booster were tested just prior to the rebuild work being undertaken with the results as shown below. Clearly the output of the compressor was well down and after some repairs to the compressor regulation system, the unit was returned to service.

The owner reported a noticeable increase in the output pressure from his booster, increased metres per day and, best of all, the booster did not require any work at all. The cost amounted to the test work plus a regulator kit and some adjustment.

Note that the navy line is the original test and the green line is the final test. Lack of inlet pressure to the booster was the culprit here.

Contractor #2

The second example illustrates the results of two tests conducted on a pair of compressors of the same model. Both were connected to a single booster and the driller was complaining about “a lack of air” neither unit had any reported problems. Each unit was having regular oil analysis and nothing abnormal was showing up. One of the units had 12,918h (red graph) and the other 16,336h (green graph).

It is interesting to study the output curves of these units. The most noticeable difference being slope of the line as the pressure rises during the test. The further the line slopes to the left the greater the internal slippage in the unit.

Both units would make full pressure, however, the output of the older unit was noticeably less than the other unit (the engine RPMs were matched for testing). The fuel burn each day was the same for each unit. The fall off in output of the older unit as the pressure shows the increasing internal leakage occurring.

The small erratic area at the bottom of the graph is often observed and is due to the action of the minimum pressure valve and does not indicate a problem.

On the basis of this test work, the high unit was removed from service and dismantled. The findings were interesting. One thrust bearing in the HP element on the male rotor had been slowly turning in the housing allowing increased discharge end clearance. The other bearings were good and the mechanical seal was almost worn out.

The unit was fitted with a new set of bearings, the housing made good and the unit returned to service at a modest cost. This unit would have almost failed with significant damage if it had been allowed to continue in operation.

Contractor #3

The final example in this article concerns a rig compressor plus auxiliary compressor and booster combination that the crew had been complaining about for many months. Fitters had checked the units without any fault being found and the rig was known as a non-performer among the drill crews.

Testing started with the auxiliary compressor which performed very well, then the rig compressor was tested. The unit was to go to a difficult site where it would be drilling with rig air alone.

The drive engine RPM was checked and found to be correct. The flow meter was then put to work with a surprising result. The output of the compressor was about 30% down on the expected result. A serious investigation into the compressor ensued and after each item was checked or repaired as deemed necessary the unit was retested.

The results were nothing short of dramatic. The compressor output was returned to as-new condition and the drill crew was very happy, as were the owners. Total cost a test plus a few hundred dollars worth of service parts for the control system.

Testing started with the red line and progressed with the navy and light blue lines finally the green line showed the actual output of this unit.

Yes, the drill crew was happy with the changes.

There are many more examples where performance improvements of a similar order have been obtained however space is limited and we may address them in another article in the future.

Testing Strategies

- Test if you suspect a problem of if there is a downward trend in production for no obvious reason.
- Test periodically to ensure that all the compressor control systems are performing correctly. A routine “tune up”.
- Test new and rebuilt units, as even new units have been found to have problems and if not found at the outset the drill crew will assume that substandard performance is “normal”
- As a seller a tested unit represents known value to a purchaser.
- As a purchaser, a 100% load test will show up problems quickly.

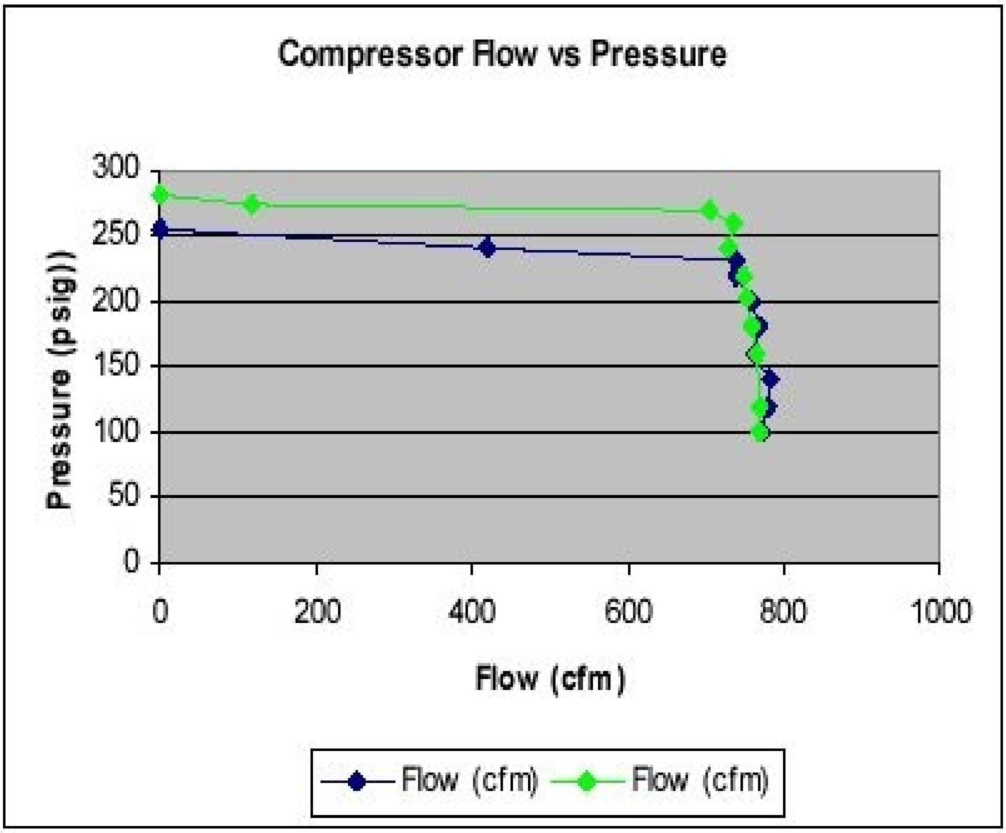
All of these reasons for testing are valid; the issue is what is the most cost effective approach. Most compressors must have their pressure vessels inspected routinely and combining the inspection work with system output testing is a good approach.

In addition by fully testing the control and shutdown systems at the same time the units can be expected to run well until the next routine inspection is due. Using the services of a licensed In Service Pressure Vessel Inspector to perform the inspection and analysis work reduces duplication and will speed up the work.

Any testing work should be carried out using procedures laid out in accepted standards, as well as having test equipment that is certified. All gauges should have current certificates of calibration from a recognised service centre.

Avoiding the loss of even one day’s production will more than cover the cost of the type of work described and any performance gains will be a bonus for the owner and the drill crew as well as making the client happy.

See you at DrillFest in the West.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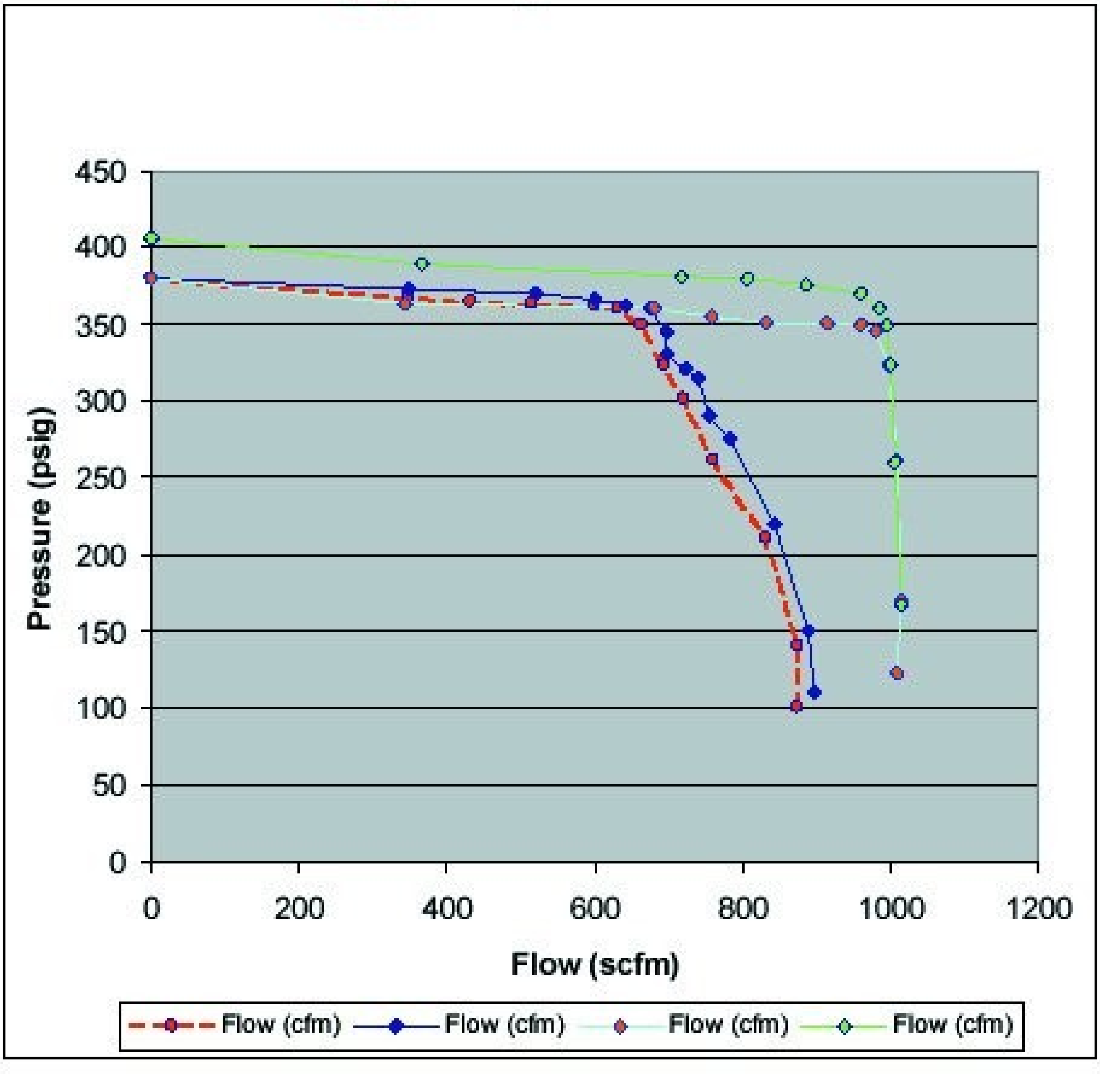
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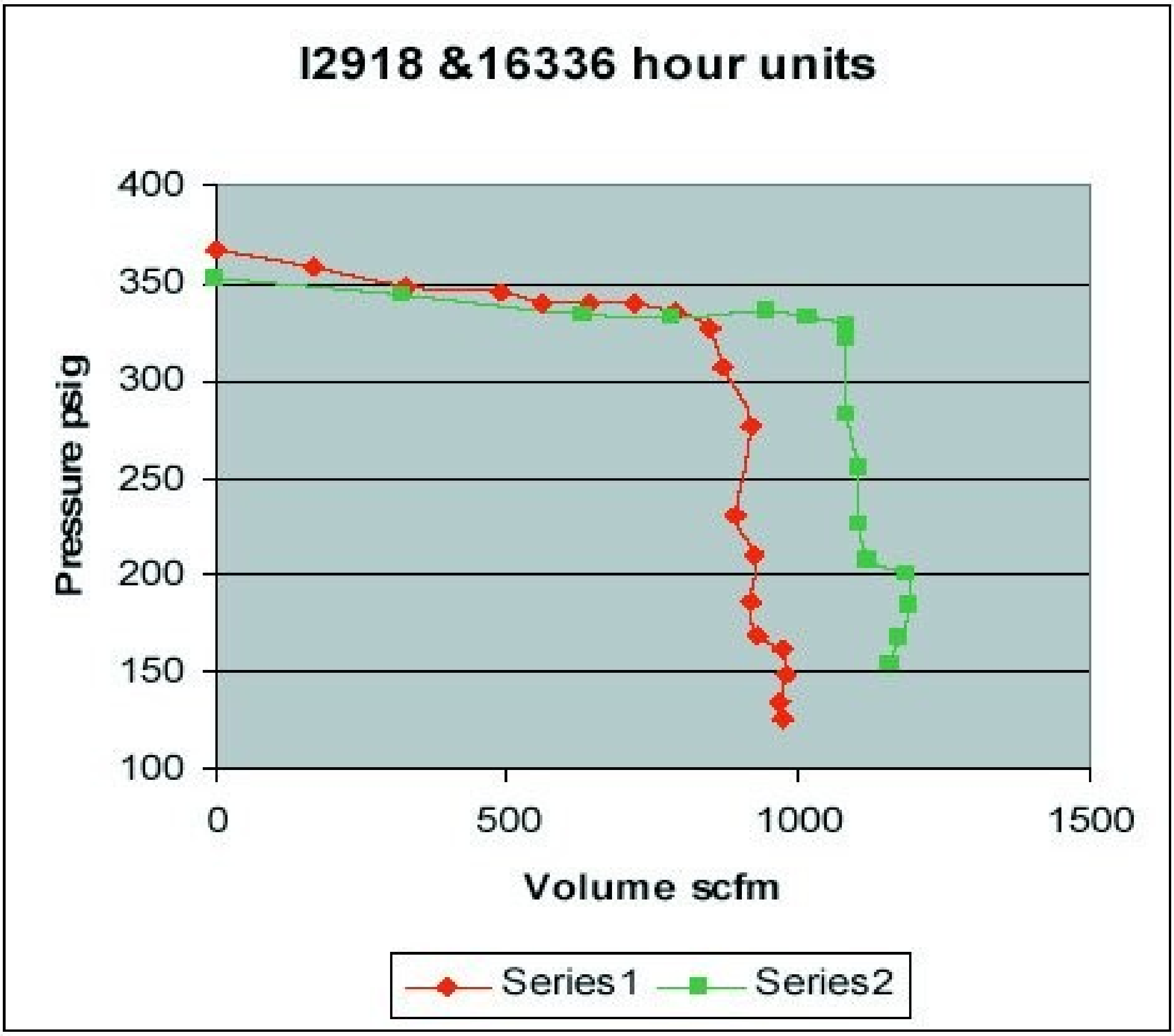

l2918 &16336 hour units
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Pressure psig
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500
1000
1500
Volume scfm
Series1
Series2