REFRIGERATION REVIEW

Are All Screw Compressors Created Equal?

My learning curve on screw compressors began in the late 1960s when Lewis Refrigeration installed this new technology for a SeaPak plant in St. Simons Island, Georgia, and it certainly became apparent after startup that the condensers weren't large enough for the rated tonnage (TR) of the system. As is well known, in reciprocating machines the condenser tonnage had traditionally been determined by adding the BHP of compressors converted to BTUs to the evaporative load of the system. This was obviously not possible with screw compressors, and a new method of calculating condenser capacity was started using MBH required for screw compressors. Is this a case of perceived value?

The second revelation came when we had a project using one Dunham-Bush compressor which was packaged by Frick, and later had an addition -- the same model Dunham-Bush, which was packaged and installed by FES. In observing the singular suctions on the system by turning one screw on and then turning it off and then turning the other screw on, it became obvious the capacities were vastly different, and the suction of one Dunham-Bush screw was 10 pounds lower than the other Dunham-Bush model.

The third revelation came when on another project I was able to compare the suction of a 250 HP screw compressor against a 250 HP reciprocating machine, and measuring the motor amperes of both, and calculating the difference in TR of the suction of the reciprocating

machine, which was better than the screw compressor, and determining there was a 36% net difference in efficiency between the screw compressor and the reciprocating compressor. The screw compressor in this case had just been rebuilt by the factory to bring it up to original specifications.

The obvious variations in capacities are the blow-by that screw compressors have which piston machines basically eliminate with piston rings, oil rings, and the like.

It will be noteworthy to mention that piston machine efficiencies are directly proportional to the bore of the piston. The bigger diameter the bore, the less the percentage of clearance represents of the total displacement. That's why the efficiencies of the old VSA machines with pistons of 10", 12", and 14" were by far the most efficient compressor machines and is why small bore screw compressors are less efficient, particularly when operated at higher speeds (i.e., 3600 rpm).

Screw compressor efficiencies are primarily a function of tip speed of the rotors, and that is often a function of the diameter of the rotors. The two attachments below, provided by SRM, the original patent holders of screw compressor profile, make that very clear. Some people are convinced that all screw compressors have to operate at 3600 rpm to be efficient, which isn't true.

Small bore screw compressors have a compound problem of the smaller diameter of the lobes plus the unload devices, such as mechanical slides and variable VI devices, will also contribute to the blow-by. As these components wear and the clearances open up, more blow-by occurs.

If you look at it from a bearing support perspective -- whether it's a ball bearing, roller bearing or journal bearing -- all bearings have tolerances, and ball bearings have what's known as a B-10 life as they wear. A ball

or roller bearing at best may have a .002 play, generally more like .003. A journal bearing when new might rotate on an oil film of .002, but soon will be .003 or .004. When twin screws wear, it obviously provides a clearance between the barrel and screw lobes of .006 to .008 as the screw compressor gets old. In screw compressors, oil is heavily injected to help seal the clearances and minimize blow-by. The reason additional oil cooling is necessary is because of the friction (joule) effect, converting friction to heat. Oil in piston machines is much more benign and generally you would expect less than .001 clearance between the piston ring and the cylinder wall, and the oil film would provide lubrication and sealing quite easily.

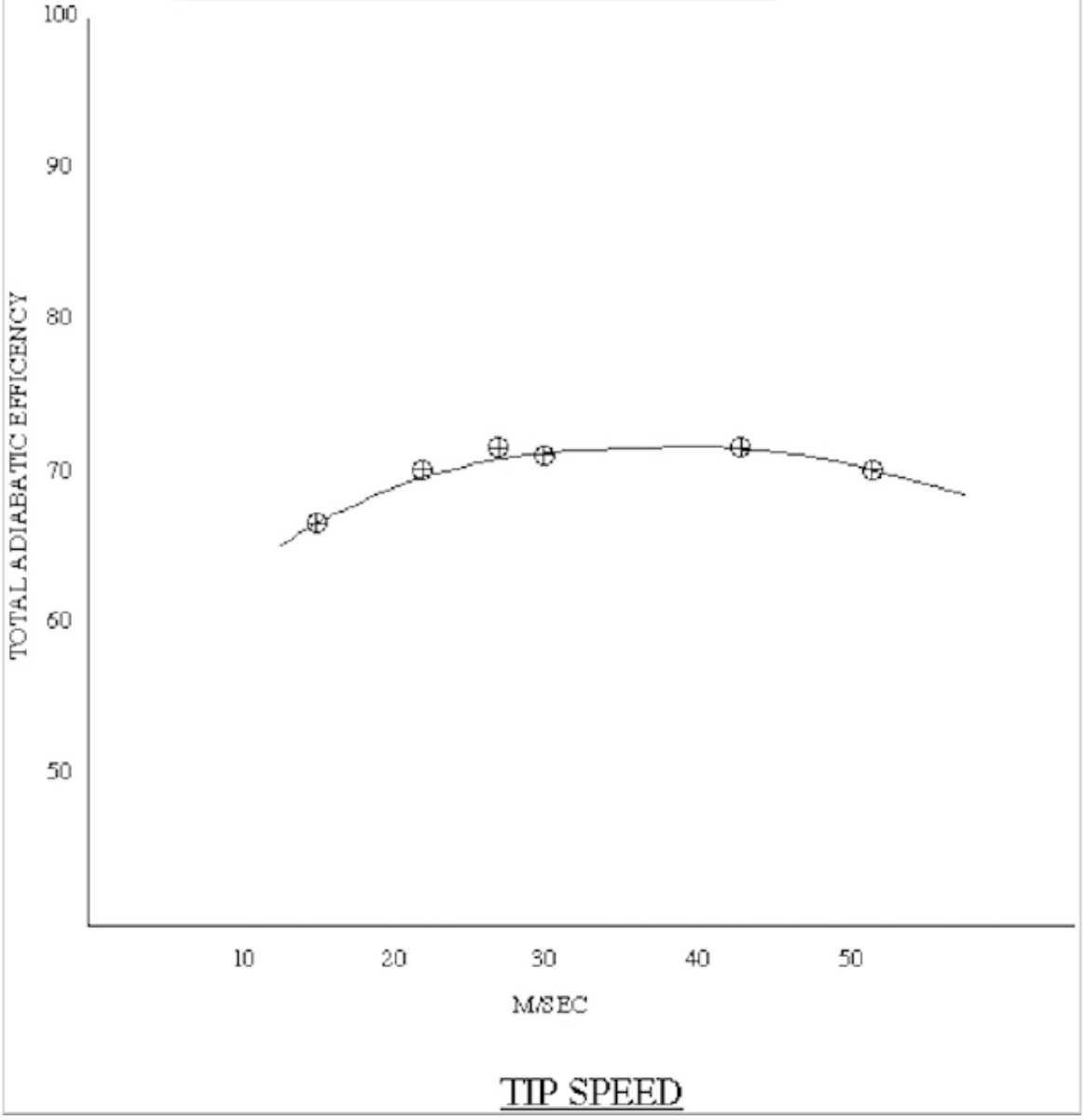
So, the answer to the question: no, all screw compressors are not created equal. I have asked screw manufacturers for years to provide a screw without an unload device or variable VI mechanical internal. They can be started like we used to start the big cylinder VSA machines, bypassing to get them up to speed, where they can provide useful work at optimum efficiency.

This is one reason the mono screw is showing the best longevity and overall efficiency, because you only have one set of journal bearings on the main rotor and the star is a phenolic, replaceable counterpart.

So, you be the judge. If the industry would install accurate flow meters along with motor amp devices, the truth would become apparent. The sad part is that it may be more cost effective to manufacture a screw compressor than, say, a 600 HP piston machine, but now you know the rest of the story.

GRAPH 2

SRM REPORT 1332/1R=124
vi = 3.5:1 PRESS RATIO = 8:1
OIL; 60L/MIN
DISCHARGE CLEARANCE MALE : .08 mm
FEMALE : .011 mm
COND. TEMP. 30°C (86°F)
(154.5 PSIG)
(169.2 PSIA)



TIP SPEED

GRAPH 3

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