THE "STRANGE" MACHINE

by Gary Weidner

If your shop services only the brand(s) of pressure washers that your company sells, you may not need what follows. Here's the scenario: a new customer wheels in for repairs a cold water washer such as you've never seen before. The customer didn't bring along the hose, wash gun, or nozzle. At a glance, it looks totally unfamiliar.

You look the unit over and find the manufacturer's nameplate, but it turns out to be one of those that gives no significant information, or else the nameplate is missing. The customer offers little help when asked about the machine's ratings.

Be a Detective

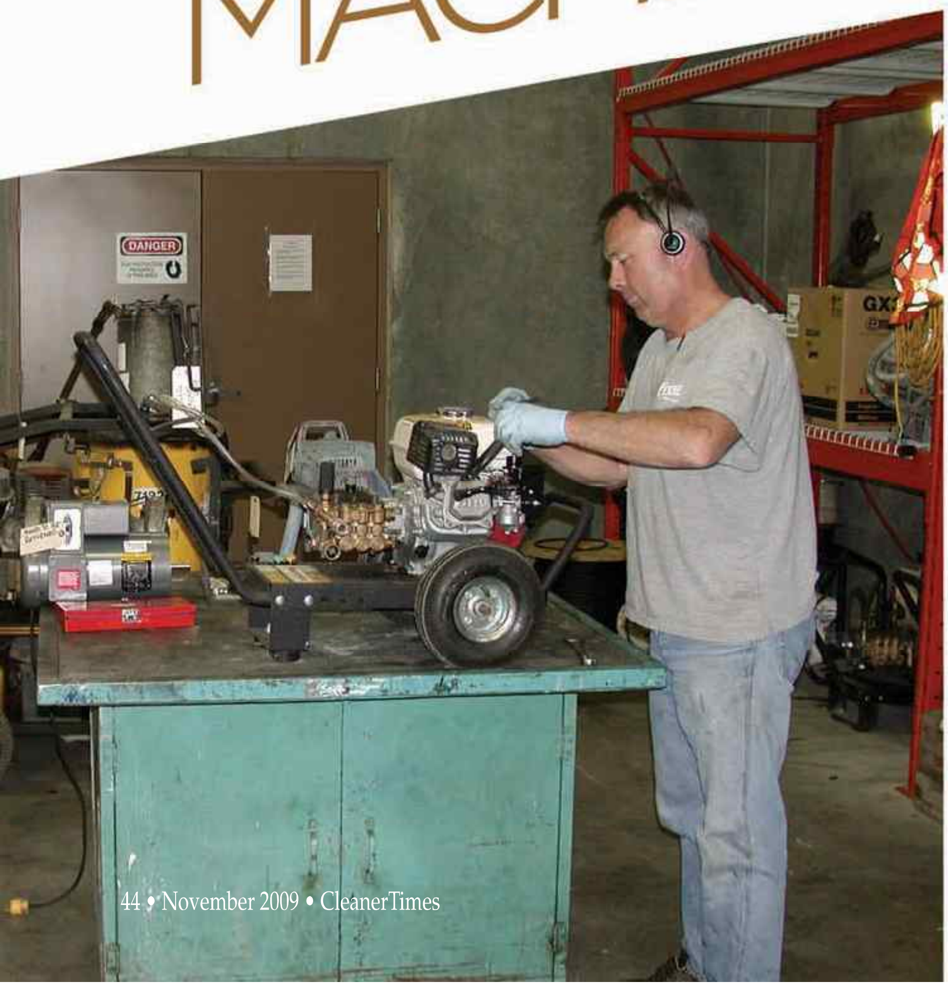
In order to evaluate the condition of this machine, you're going to have to do some detective work. The objective is to piece together bits of information to figure out the ratings of the machine. The needed information is usually there—you just have to dig it out. This chapter points out things you can do to get a fairly close idea of what the numbers are for this machine.

Information on File

The first thing to do is to spend a few minutes reviewing what helpful information might be stored in your files. (Remember, to be productive at your job, it helps to collect information.) You look through your literature from other machine manufacturers to check a couple of possibilities, but you don't find this unit. If there's no brand or other information on the machine, web searching doesn't help much either.

Hints from Components

You may find one or more components on the machine that either have



ratings marked on them or that you recognize and can look up their ratings. Yes, the ratings for components usually span a range of psi and gpm, but at least you know the range in which the machine is designed to operate. Examples of such identifiable components are a relief valve, an unloader, or a pump.

The Pump Driver

Very useful information can usually be gathered from the motor or engine that drives the pump. The two items of information to look for on an electric motor are horsepower and rpm. On an engine, look for the horsepower. (The engine rpm is not exactly constant, and even if it is, the engine may no longer be running at the speed originally set up by the pressure washer manufacturer.) We will make use of these numbers below.

The Drive Mechanism

What we're after is to pin down the rpm at the pump crankshaft. To do that, we have to consider whatever drive mechanism lies between the pump driver and the pump. In the simplest case, direct drive, the pump rpm equals the motor rpm. In the case of a gear-reduction drive, the pump rpm equals the engine rpm divided by the gear ratio.

In the case of a belt drive, you are interested in the ratio of the diameters of the pulleys on the pump and motor. Then you can use this formula:

$$\text{pump rpm} = \text{motor rpm} \times \frac{\text{motor pulley diameter}}{\text{pump pulley diameter}}$$

For example, suppose that motor rpm is 1725, motor pulley diameter is 4 in. and pump pulley diameter is 8 in. Then:

$$\text{pump rpm} = 1725 \times \tfrac{4}{8} = 863$$

The Pump

The high pressure pump may carry an information label. With a little luck, the label will specify maximum flow, pressure, and rpm. If the flow and pressure numbers are not in units of gpm and psi, refer to the box showing conversion factors.

If there is no information marked on the pump, you can get its displacement the hard way—pull the pump head and measure the bore (piston or plunger diameter) and stroke (length of travel from end-to-end of a stroke). For example, suppose you measure a piston diameter of about 0.9 in. and stroke of about 0.65 in. Then the displacement of one cylinder can be calculated from this formula:

$$\begin{aligned}\text{cylinder displacement} &= 0.79 \times (\text{bore})^2 \times (\text{stroke})\\ &= 0.79 \times (0.9)^2 \times (0.65)\\ &= 0.79 \times 0.9 \times 0.9 \times 0.65\\ &= 0.42 \text{ cu. in.}\end{aligned}$$

This result must be multiplied by the number of cylinders to get total displacement for one revolution of the crankshaft. If there are three cylinders,

$$3 \times 0.42 = 1.26 \text{ cu. in. per revolution.}$$

Putting the Numbers Together to Get the Flow

What use is the preceding work? Consider the unmarked pump on which we measured the displacement, and the drive (rpm) calculation we did above. You can multiply the displacement per revolution by the revolutions per minute to get the displacement per minute (flow):

$$1.26 \frac{\text{cu. in.}}{\text{revolution}} \times 863 \frac{\text{revolutions}}{\text{minute}} = 1087 \frac{\text{cu. in.}}{\text{minute}}$$

Using the conversion factor for gallonage from the box,

$$1087 \frac{\text{cu. in.}}{\text{minute}} \times 0.0043 = 4.7 \text{ gpm}$$

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course. In response to a question whether an MSDS would be required for coal, the reminder was made that coal dust is classified as a hazardous chemical and that coal dust is unleashed as coal is handled. So, yes, coal requires an MSDS.

The coal mine should provide an MSDS, according to the Directorate. One bit of relaxation: A fuel producer that uses coal does have the option of using a generic MSDS. The OSHA Hazard Communication Standard (HCS), 29 CFR 1910.1200 allows the use of a generic MSDS for compounds with similar hazards and characteristics. (CFR is the Code of Federal Regulations.)

Harmonization

Since 2003, participants in the Globally Harmonized System of Classification and Labeling Chemicals (GHS) have been working (under the auspices of the United Nations) toward a universal system, or GHS, for labeling chemicals and compounds. The system is still in the works, although a definitive date for full implementation is not available.

Each participating country in the GHS reports its progress separately. The most recent report from OSHA, on behalf of the United States, cites October 2009 as the month when the proposal for GHS in the U.S. workplace will be published and ready for comment. According to OSHA, the provisions of the GHS will be relatively similar to those of OSHA's HCS. OSHA will issue a press release when the text is available for review.

Once the rule to comply with GHS is adopted, a process that could take as many as 18 months after the October 2009 review period starts, compliance will begin. But it is most likely that compliance will be phased in over several years. Use the URL cited in the first section of this article to find a menu that includes a link to the most up-to-date information on the GHS. *CT*

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We now have the gpm of the pump.

Suppose that the pump did have an intact label that specified "max flow = 5.7 gpm, max speed = 1050 rpm." You can adjust the label flow for this machine's pump rpm as follows:

$$\text{new gpm} = \text{label gpm} \times \frac{\text{new rpm}}{\text{label rpm}}$$

For the example motor and pulley set above,

$$\text{new gpm} = 5.7 \times \frac{863}{1050} = 4.7 \text{ gpm}$$

In any event, you now have used one of the above methods to determine the pump rpm and gpm for this machine.

Finding the Pressure

To complete the picture, you need to use one more formula:

$$\text{approximate psi} = 1460 \times \frac{\text{hp}}{\text{gpm}}$$

You looked at the electric motor and found it to be 6 hp. Knowing that and the 4.7 gpm pump flow, you can utilize the formula above:

$$\text{approximate psi} = 1460 \times \frac{6}{4.7} = 1864$$

Bingo! You now have the machine's flow and pressure. Reference to a spray nozzle chart will tell you what wash tip is needed to produce 1864 psi from a 4.7 gpm flow. Of course the answer (#6.5 tip) is approximate, but it will be close.

More Complicated with Engines

If the machine just discussed had an engine instead of the 6 hp electric motor, the engine might fall in the range of 9–11 hp. This is because a gasoline engine horsepower rating has to be considerably more than the rating of an electric motor that does the same job. The extra horsepower rating required for an engine could be anywhere from 1.4 to 1.8 times that of an electric motor, depending upon the type of engine.

Some Notes

These calculations are not as exact as all the decimal places on your calculator! For example, the factor 1460 in the horsepower formula above varies slightly from pump-to-pump because it is related to the efficiency of the pump. Also, the use of pulley outside diameters for the ratios is a slight approximation, as the "pitch diameter" must be used if maximum accuracy is desired. Pump volumetric efficiency and unloader bypass flow are also not accounted for here. But the bottom line is that we have come up with reasonably close numbers for the rpm, flow, and pressure of the pump.

Here is an occasional annoyance to keep in mind when having to infer a machine's ratings from its components: over the machine's life, someone may have worked on it and replaced original component(s) with component(s) of different ratings. Examples would be a larger or smaller motor or pump.

Finally, everything that's been said applies equally well to hot water washers. *CT*

Conversion Factors

Multiply This:	By This:	To Get This:
kg/cm^2	14.22	psi
psi	0.07	kg/cm^2
bars	14.5	psi
psi	0.07	bars
kPa	0.145	psi
psi	6.90	kPa
MPa	145.0	psi
psi	0.0069	MPa
l/m	0.264	gpm
gpm	3.79	l/m
cubic in.	0.0043	gal.
cubic cm.	0.00026	gal.
hp	746.0	watts
watts	0.00134	hp

Key Concepts

- An unidentified machine can usually be figured out.
- Rated flow and pressure can be calculated from observations and measurements:
  - ~ Pump driver rpm
  - ~ Drive mechanism (power transmission)
  - ~ Pump displacement
  - ~ Horsepower