Flow or Pressure?
See and Sell the Value of Flow

Ben Hagemann
American Pressure Inc
Minneapolis, Minnesota

American Pressure Inc.

- It has been said that water without pressure is just a puddle

- We must also remember that pressure with little water is just mist

American Pressure Inc.

Pressure washers are used to clean things and they, like any other tool, are a labor saving device designed to accomplish a task as cost efficiently as possible.

American Pressure Inc.

Comparing Two Pressure Washers with the same Cleaning Units

Machine 5-18

- 5.0 GPM
- 1800 PSI
- Natural Gas
- Electric Drive
- 9000 Cleaning Units
- 6.16HP, 500,000 BTU

Machine 3-30

- 3.0 GPM
- 3000 PSI
- Natural Gas
- Electric Drive
- 9000 Cleaning Units
- 6.16HP, 300,000 BTU

Hourly Cost To Operate

Machine 5-18

- $6.09 + $20.00 Labor
- **$26.09/Hour**

Machine 3-30

- $3.79 + $20.00 Labor
- **$23.79/Hour**

- Based on the following assumptions:
  - Natural Gas $0.65/Therm
  - Electricity: $0.12/KW
  - Water: $2.00/100Gal
  - Labor: $20.00/HR
  - 60% Trigger Pull Time

American Pressure Inc.

Reaction and Impact Force

- Reaction force:
  - The force of the water leaving the nozzle.
- To double the force:
  - Water volume doubled
  - Pressure quadrupled
- Pounds of force

  = .0526 x volume x square root of pressure

How Fast Do They Clean?

	Machine 5-18	Machine 3-30
• Hourly Cost	$26.09	$23.79
• Impact Force	11.16	8.64
• Cleaning Time	6.2 hrs	8 hrs
• Cost	$161.76	$190.32
• Savings		
– Per Day	$28.56	
– Per Year	$7140.00	

American Pressure Inc.

250 Days of Work Later....

Machine 5-18

- 279,000 Gallons of Water
- 4650 Therms of Natural Gas
- 7,130 KW of Electricity
- 450 Hours Saved!

Machine 3-30

- 216,000 Gallons of Water
- 3600 Therms of Natural Gas
- 9,200 KW of Electricity

What Is The Ideal Pressure?

- The ideal pressure is slightly more than the amount required to clean.
  - If a surface can be cleaned with 800 PSI, then 1000 PSI would be close to an ideal number.
  - If 2900 PSI is required then 3000PSI or 3500 PSI would be close to ideal.
- After you know the pressure to clean, increase water to clean and not pressure.

American Pressure Inc.

Too Much Water?

- We can have too much water.
- 4, 5, or 6 GPM are good for many applications.
- 7-10 GPM approach the size limits of machines and utilities and require larger hose ID's.
- More than 10 GPM is generally not used often by a single user.

Effective Cleaning Distance

- Too Close you do damage
- Too Far away you don't clean
- Higher water volume to pressure ratio increase effective cleaning distance.
  - 1.0 GPM Per 1000 PSI is a good minimum (1@1000, 2@2000, 3@3000, 4@4000)
  - 2.0 GPM Per 1000 PSI is better (2@1000, 4@2000, 6@3000)

Droplet Size

- Higher pressure at the same volume leads to smaller droplet sizes.
  - The smaller droplets decrease cleaning efficiency and waste energy due to more surface area being exposed.
- Due the complex nature of the atomization of spray, empirical data is relied upon heavily for droplet size.
- Air Temperature and Humidity also have a significant effect.

American Pressure Inc.

Test Time!

- 5 GPM
- 175°F
- 1000, 2100, 3600 & 4700 PSI
- 6, 12, 18 & 32”
- 15° Nozzle

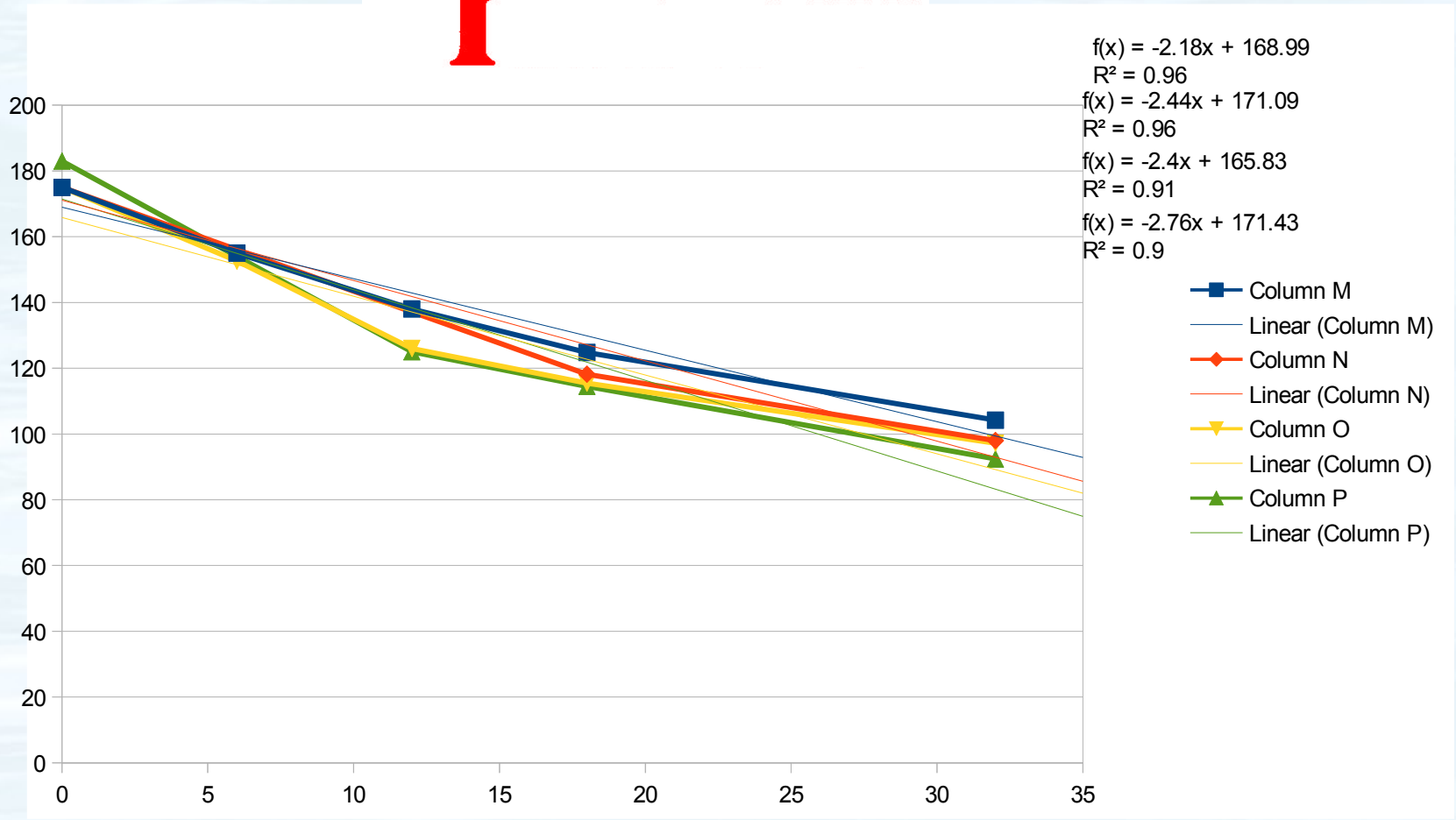
- Monitor Flow, Volume & Temperature
- Measure Impact Force & Plate Temperature.

Findings

American Pressure Inc.

- Clear trends were found on Temperature and Impact
- 2.18°F lost per inch at 1000 PSI 39.2°F lost at 18” 21.2%
- 2.76°F lost per inch at 4700 PSI 49.7°F lost at 18”
- 4700 PSI yielded 24.8% Less of the expected Impact as compared with 1000 PSI.
- Limited Data set, slight test flaws, various control issues. The data set fit logarithmic models, but for simplicity we are using linear modeling At 5GPM on a 68°F day from 1000 to 4700 PSI. We will conservatively say for every 100 PSI we loose .5% of thermal and mechanical energy.

American Pressure Inc.



A 1200 PSI Increase in Pressure Yields a 6% Loss in Heat and Impact Force

	Machine 5-18	Machine 3-30
• Hourly Cost	$26.09	$23.79
• Impact Force	11.16	8.64
• Cleaning Time	5.8 hrs	8 hrs
• Cost	$151.32	$190.32
• Savings		
– Per Day	$39.00	• About 28% LESS impact!
– Per Year	$9750.00	

Key Selling Points on Flow

- Larger safe and effective cleaning range
- Less chance of damage
- Larger average drop size
- Improved bottom line for customer
- Improved temperature at distance
- Impressed, informed and loyal customers

American Pressure Inc.

This slide provides highlights and notes to this brief presentation given at CETA PowerClean 2013. Feel Free to contact me for more information Ben@AmericanPressureInc.com or 763-521-4442.

It is important to put yourself in the customers position, what does he want from his pressure washer and how does he view it? He should think of it as a tool or anything else used in business and it should be selected in an informed way that solves his needs. Work hard to help your customers and their businesses.

Cleaning Units (pressure x volume) is a commonly marketed bit of information in our industry. It is a poor way to compare units for any knowledge of how they will 'clean'. Impact or Reaction force is a much better comparison and deals with how much force(speed and mass) is leaving the nozzle and could impact the surface being cleaned.

The slides deal with a comparison of two pressure washers that use the same HP motor and have the same amount of cleaning 'units'. There is a calculation of the cost to operate both units, we first use simply impact force(neglecting rinsing, droplet size, effective cleaning distance, etc). We can see that using the horse power to drive more volume is saving significant time and electricity, while using more water and fuel.

Droplet Size, the higher the pressure the more droplets and therefor the more surface area, increasing pressure will decrease droplet size, decreasing flow will have the same effect. The more droplets or atomization the more energy, both thermal and mechanical is lost through the air. We only tested 5 GPM at various distances and pressures and we found for every 1000 PSI you lose at least 5% of the expected temperature and impact at distance. It is also important to note that significant temperature is lost over distance. We did testing outside(to simulated a well ventilated area) while the ambient temperature was 68°.

Now we consider effective cleaning distance. As you get too far away you stop cleaning, when you get too close you start to do damage. The higher the pressure at the same volume the longer the distance required to not do damage to the surface being washed. All applications will vary, but lets say at 1000 PSI we could clean at 6” with a 40° Nozzle (4.4” path) and at 4000 PSI we could clean with a 15° Nozzle at about 18” (4.7” Path). To have the same water temperature at impact we would need to run the 4000 PSI machine at 180°F, while we could run the 1000 PSI unit at 147°F.

Generally speaking we are ignoring many factors in these example that tend to benefit the higher volume/lower pressure machines(rinsing, component longevity, ease of use, etc), these areas are more qualitative and will only enhance the benefits of higher flow instead of higher pressure for the user of the equipment when more closely examined.