



DJAM PUMP SPECIALISTS

PUMP KNOWLEDGE SERIES



CENTRIFUGAL PUMP

AFFINITY LAWS



Centrifugal Pump Affinity Laws

First off, I have to apologize for my last Centrifugal Campaign, I made an error in how I described the Affinity Laws. I stated that the Laws were inversely proportional, which is incorrect. The laws are actually directly proportional and I will go into more detail below.



1. Centrifugal pump curves start with data based on water with a specific gravity of 1.0.
2. Computer generated curves now can show the curves for different specific gravities.
3. Centrifugal pump flows are determined by the Head the pump will see across the pump. Head can be converted to pressure by using the specific gravity.
 $H(\text{meter}) = 10.2 P/SG$ or $H(\text{feet}) = 2.3P/SG$.
4. Centrifugal pumps follow certain Laws of Affinity
 - Flow is **directly** proportional to the speed.
 - Flow is **directly** proportional to the impellor diameter.
 - Head is **directly** proportional to the square of the speed.
 - Head is **directly** proportional to the square of the impellor diameter.
 - Horsepower is **directly** proportional to the cube of the speed.
 - Horsepower is **directly** proportional to the cube of the impellor diameter.

BELOW ARE THE THREE

AFFINITY LAWS

Law 1: Flow is Proportional to Shaft Speed or Impeller Diameter

This law means that as shaft speed or impeller diameter changes, flow changes by the same proportional amount. In other words, if shaft speed increases by 10% then flow at the same head will also increase by 10%. This law is expressed with the following formula:

$$Q_1/Q_2 = (N_1/N_2) \text{ or } (D_1/D_2)$$

Where Q is equal to flow, N is equal to shaft speed, and D is equal to impeller diameter.



Law 2: Pressure is Proportional to the Square of Shaft Speed or Impeller Diameter

As shaft speed or impeller diameter changes, pressure changes in proportion to the square of the change in shaft speed or impeller diameter. In other words, if shaft speed increases by 10% then pressure at the same flow will increase by 21% (1.10 squared). This law is expressed with the following formula:

$$H_1/H_2 = (N_1/N_2)^2 \text{ or } (D_1/D_2)^2$$

Where H is equal to head, N is equal to shaft speed, and D is equal to impeller diameter.



Law 3: Power is Proportional to the Cube of Shaft Speed or Impeller Diameter

As shaft speed or impeller diameter changes, horsepower changes in proportion to the cube of the change in shaft speed or impeller diameter. In other words, if shaft speed increases by 10% then pressure at the same flow will increase by 33.1% (1.10 cubed). This law is expressed with the following formula:

$$P1/P2 = (N1/N2)^3 \text{ or } (D1/D2)^3$$

Where P is equal to power, N is equal to shaft speed, and D is equal to impeller diameter.

If you have any field application or premature wear/failures of any of your centrifugal pumps, I am available to do a virtual or on-site inspection and offer you solutions to your problems. Call Mike at 403-333-7405 or check out my website at www.djampumps.ca.

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