IMPROVING VISCOSITY & FLOW

WITH POWERBLANKET

TEMPERATURE IS A MAJOR CONTROLLING FACTOR WHEN DISCUSSING VISCOSITY AND FLOW. POWERBLANKET HAS SEVERAL SOLUTIONS FOR YOUR VISCOSITY NEEDS.

VISCOSITY AND FLOW CONTROL

Viscosity is a complicated and sometimes confusing topic and understanding how to lower viscosity is a challenge during cold winter months.

VISCOSITY REDUCTION BASICS

A fluid that is viscous will be thick, sticky, and semifluid in consistency. You can lower viscosity by adding friction and/or increasing temperature. For example, consider what happens when you need some ketchup on your burger. If you simply invert the bottle and expect the ketchup to flow freely, you are a rookie in the sport of burger-eating. A pro knows to shake the bottle and then to proceed with caution, because once you have decreased viscosity, due to the shaking, the ketchup can flow quite rapidly.

Now consider honey, certainly a substance that is thick, sticky and semifluid. Simply shaking a jar of honey will not guarantee any flow. Honey cooled in a refrigerator will have little to no flow because it has been cooled, but when warmed appropriately (do not heat honey above 100°F), there is a viscosity reduction and honey will flow smoothly. The viscosity concepts that apply to ketchup and honey translate to gases and industrial materials that need lower viscosity and increased flow. However, you probably aren't going to pick up a 55 gallon drum and shake it like a ketchup bottle to lower the contents' viscosity. Following are tips for improving viscosity and flow using temperature control.

WHAT DO MOLECULES DO?

Remember this: cold molecules are sleepy and sluggish. Warm/heated molecules are ready to move.

When dealing with gases where external ambient temperatures are lower, it is very difficult to maintain an optimal gas flow rate. Lower temperatures equate to fewer molecule collisions in the tank. This prevents the gas from vaporizing, rendering it virtually useless. Propane, butane, nitrogen, oxygen and other compressed gases need temperature control to ensure optimal gas flow rates. As a gas is heated, the movement of gas molecules increases and the probability that one gas molecule will collide with another gas molecule increases. In other words, increasing gas temperature causes the gas molecules to collide more often. Bringing the container/system up to a temperature above the cooler existing ambient temperature will result in increased pressure, flow and efficiency.

CASE IN POINT

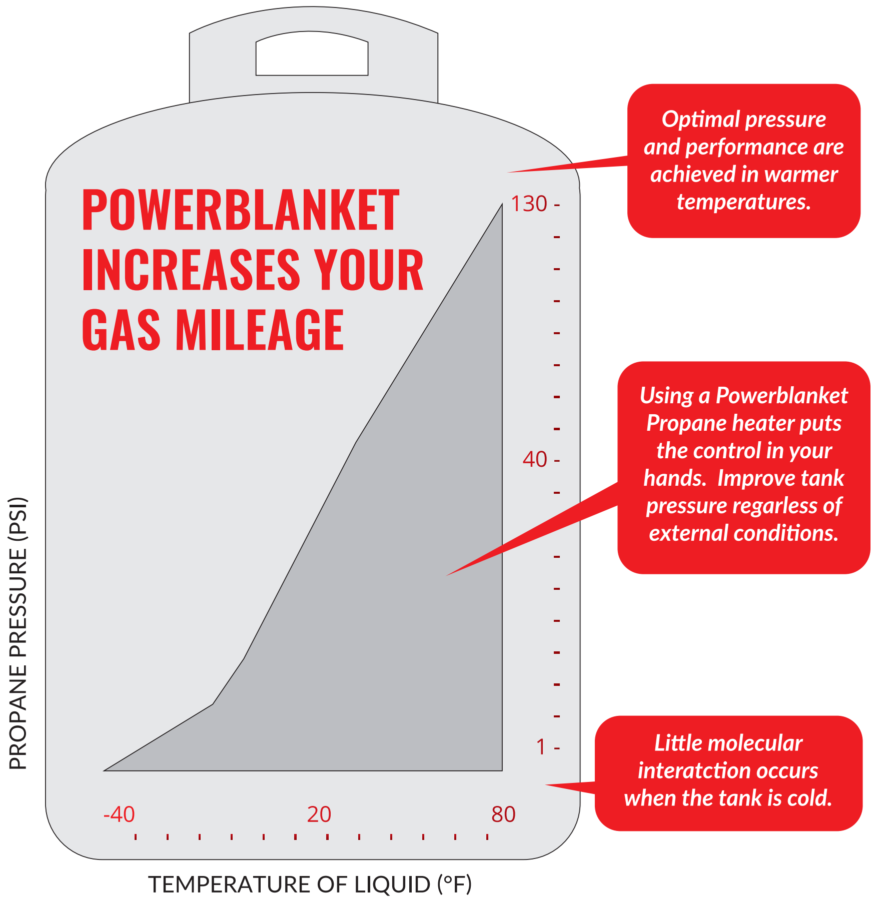
A large semiconductor manufacturing company needed a new product to improve their semiconductor manufacturing process. They needed to maintain the flow of their gas delivery system more precisely, and their existing solution did not offer the consistency they desired.

Powerblanket designed a heating product for their gas delivery system that maintained the precise temperature and gas flow rate for hydrocarbon gases.

The company's management team later admitted that they were initially against the idea of switching to the Powerblanket specialty gas heating solution. They said, "We didn't think it would work because it was half the power of the status quo product, but after we gave it a try, we were immediately sold. It's a fantastic product. Flow and pressure are no longer a problem, and the sales and engineering support we received was excellent."

ANOTHER EXAMPLE

Shannon Stillman, a Pyro Engineer at Thor Productions, said, "We use propane in large volumes – over ½ ton each night per event. Each of our cylinders are wrapped with a Powerblanket Gas Cylinder Heater, extending the allowable duration by at least 60%. This equates to hundreds of usable lbs of propane per night. In addition, the UL listing and safety ratings of the Powerblanket products resolve the concerns of the site safety managers, AHJ's (Authorities Having Jurisdiction) and Fire Marshals."



WHAT AFFECTS LIQUID VISCOSITY?

In a liquid there will be molecular interchange similar to those developed in a gas, but there are additional cohesive forces between the molecules of a liquid (which are much closer together than those of a gas). Both cohesion (shaking the ketchup) and molecular interchange (warming the honey) contribute to liquid viscosity.

Increasing the temperature of a liquid will reduce the cohesive forces while simultaneously increasing the rate of molecular interchange. The increase in temperature causes the kinetic or thermal energy to increase and the molecules become more mobile.

CONSIDER OIL

When your lubricant is too viscous (thick), it affects the ability the liquid has to flow easily. When dealing with small engine parts, using a highly viscous lubricant could restrict its access to smaller parts within your engineer or mechanism. Obviously, restricted flow to vital elements of machinery could cause drastic problems.

Another problem posed by overly viscous lubricants comes from the incurrence of excessive torque in the machinery. If the oil in the machine is too thick, it's going to tax the engine all the more to push the lubricant into all the necessary locations. Undue torque on the system, and more friction than is necessary all means more wear and tear.

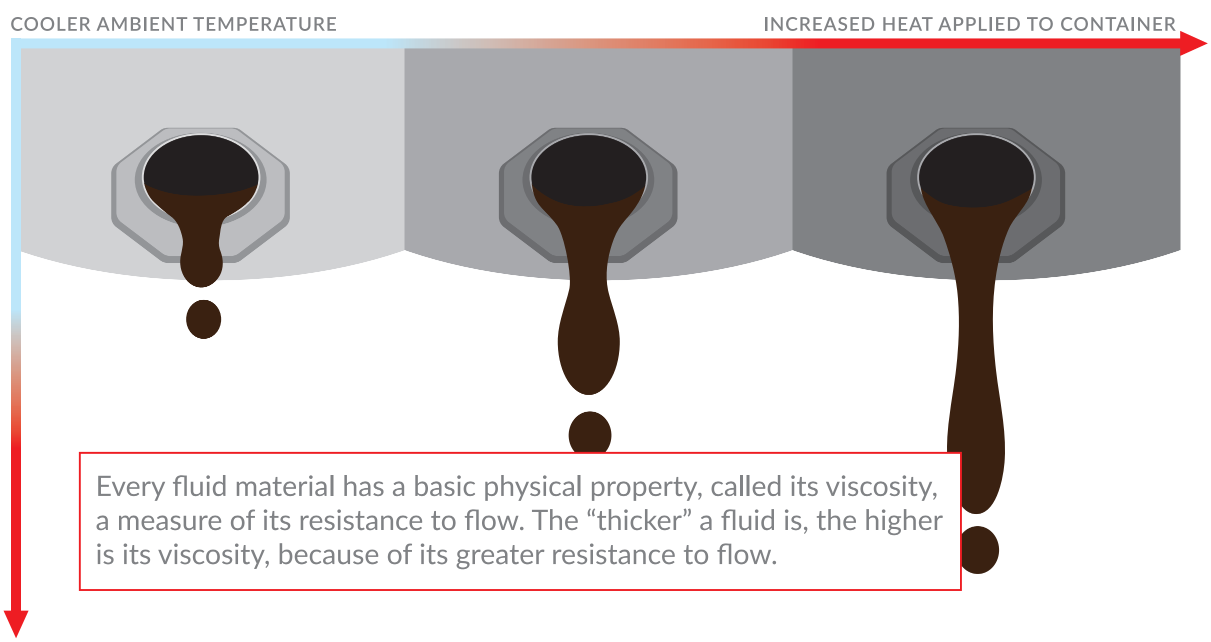
HONEY VISCOSITY

Zeller and Sons harvests honey straight from the hives and then stores it in big barrels. At first, they didn't have an efficient way to get the crystallized honey out of the barrels. Once the honey has been harvested, it begins to crystallize which makes the honey very thick and hard. In order to jar the honey and begin making their additional products, they need to decrease the viscosity.

Warming honey can be difficult because if the temperature rises to be too warm too fast, it can cause the honey to darken and lose essential nutrients. Most beekeepers use a big tank full of warm water which they submerge a bucket of honey into and wait for the honey to decrystallize. Although this method works, it takes a long time and creates

IMPROVING VISCOSITY

When warmer temperatures are applied to thick/sticky fluids, viscosity decreases and flow increases.



the risk of ruining the honey since it can be hard to manage/gage the exact temperature of the water.

MAKING HONEY FLOW

Powerblanket developed a custom system to efficiently and effectively warm honey. With the Bee Blanket, Zeller and Sons warm high quantities of honey at a time without having to worry about the temperature rising too much. The warming blanket not only decrystallizes the honey, but it also keeps it warmed to the exact temperature needed--not to warm, not too cool. Lowering viscosity and preserving essential nutrients requires a very specific balance.

Ben Zeller, who has been beekeeping for over a decade, said "Before, it was easier for the honey to go dark and it took much longer to get it to flow." He explained, "I use the blankets as a heater to decrystallize the honey. After it's fluid, we keep it consistently warmed at 95°F using the Bee Blankets."

CALCULATING VISCOSITY

Viscosity is the measure of a material's resistance to motion under an applied force. There are several formulas and equations that calculate viscosity. If you want a simple science experiment, measure the speed of a metal ball dropped in a container of liquid. The velocity of the ball, combined with the relative densities of the ball and the liquid, can be used to calculate the viscosity of the liquid.

TRY THIS OUT

Calculating the Density of the Ball

1. Measure the mass of your ball, using your balance. For instance, suppose the mass of the ball is 0.1 kilograms (kg).
2. Find the radius of the ball by first measuring the diameter (distance of a straight line through the ball at the widest part). Divide the diameter by 2; this gives the radius of your ball.
3. Calculate the volume of the ball by plugging the radius into the equation for the volume of a sphere. Suppose the ball bearing has a radius of

VISCOSITY COMPARISON CHART

MATERIAL	VISCOSITY
WATER	1-5 CPS
KEROSENE	10 CPS
ANTIFREEZE	15 CPS
SAE 10 MOTOR OIL	85-140 CPS
MAPLE SYRUP	150-200 CPS
CASTOR OIL	250-500 CPS
SAE 30 MOTOR OIL	420-650 CPS
HONEY	2-3,000 CPS
MOLASSES	5-10,000 CPS
CHOCOLATE SYRUP	10-25,000 CPS
KETCHUP	50-70,000 CPS
PEANUT BUTTER	150-200,000 CPS
CRISCO	1-2,000,000 CPS
SILICONE SEALANT	5-10,000,000 CPS
WINDOW PUTTY	100,000,000 CPS

VISCOSITY CALCULATION FORMULA:

$$\text{viscosity} = \frac{\text{shear stress}}{\text{shear rate}}$$

The result is typically expressed in centipoise (cP), which is the equivalent of 1 mPa s (millipascal second).

0.01 meter (m). The volume would be: Volume = 4/3 x pi x (0.01 m) ^3 = 0.00000419 m^3

4. Calculate the density of the ball by dividing its mass by its volume. The density of the ball in the example would be: Density = 0.1 kg ÷ 0.00000419 m^3 = 23,866 kg/m^3

Calculating the Density of the Liquid

1. Measure the mass of your graduated cylinder when it is empty. Then measure the mass of your graduated cylinder with 100 millilters (mL) of liquid in it. Suppose the empty cylinder had a mass of 0.2 kg, and with fluid its mass was 0.45 kg.
2. Determine the mass of the fluid by subtracting the mass of the empty cylinder from the mass of the cylinder with the fluid. In the example: Mass of liquid = 0.45 kg - 0.2 kg = 0.25 kg
3. Determine the density of the fluid by dividing its mass by its volume. Example: Density of fluid = 0.25 kg ÷ 100 mL = 0.0025 kg/mL = 0.0025 kg/cm^3 = 2,500 kg/m^3*
4. 1 mL is equal to 1 cm^3 *1 million cubic centimeters equal 1 cubic meter

Measuring the Viscosity of the Liquid

1. Fill your tall graduated cylinder with the liquid so it is about 2 cm from the top of the cylinder. Use your marker to make a mark 2 cm below the surface of the liquid. Mark another line 2 cm from the bottom of the cylinder.
2. Measure the distance between the two marks on the graduated cylinder. Suppose that the distance is 0.3 m.
3. Let the ball go on the surface of the liquid and use your stopwatch to time how long it takes for the ball to fall from the first mark to the second mark. Suppose it took the ball 6 seconds to fall the distance.
4. Calculate the velocity of the falling ball by dividing the distance it fell by the time it took. In the example: Velocity = 0.3 m ÷ 6 s = 0.05 m/s

Calculate the viscosity of the liquid from the data you have collected:

1. Viscosity = (2 x (ball density - liquid density) x g x a^2) ÷ (9 x v), where g = acceleration due to gravity = 9.8 m/s^2 a = radius of ball bearing v = velocity of ball bearing through liquid.
2. Plug your measurements into the equation to calculate the viscosity of the liquid. For the example, the calculation would look like this: Viscosity = (2 x (23,866 - 2,500) x 9.8 x 0.01^2) ÷ (9 x 0.05) = 93.1 pascal seconds

POWERBLANKET SOLUTIONS

Powerblanket makes it easy to lower viscosity of many industrial fluids. Powerblanket offers various ready-to-ship products, from bucket and drum heaters to ibc tote heaters. We can also produce custom solutions for most applications. If you need help with viscosity reduction, Powerblanket has you covered.

NEED A SOLUTION FOR VISCOSITY AND FLOW?

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LEARN MORE

POWERBLANKET VISCOSITY PRODUCTS

DRUM & BUCKET HEATERS
Eliminate waste and lower costs incurred from materials damaged by improper temperatures

TOTE HEATERS IBC HEATERS
Emit safe, consistent heat to ensure your totes are stored at optimal temperatures

BULK MATERIAL WARMERS
A universal heating solution for remote-location use, job site heating, and transporting materials

DEF TOTE HEATERS
Designed specifically as an effective storage and heating solution for DEF

BEE BLANKET
Maintain honey viscosity and protect valuable enzymes without overheating or scorching

WAX BLANKET
Designed to fit a standard-sized 5-gallon metal pail, safely and efficiently melt your wax or glycerin into a usable liquid form

GAS CYLINDER WARMERS
Provide a uniform barrier of heat across entire cylinder, optimizing temperatures and increasing cylinder efficiency