REVIEW IN CAUSES OF VISCOSITY IN FLUIDS

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ABSTRACT

This review study involved causes of viscosity for fluids , general causes , effect on it , causes of viscosity in tubes . different types of flow conditioners. To calculate the pressure drop and flow rates in a section of uniform pipe running from Point A to Point B, enter the parameters below.

Keywords : non , causes , rate ,general .

No: of Tables: 1 **No: of Figures: 2** **No: of References:9**

INTRODUCTION

A fluid's viscosity strongly depends on its temperature. Along with the shear rate, temperature really is the dominating influence. The higher the temperature is, the lower a substance's viscosity is. Consequently, decreasing temperature causes an increase in viscosity. The relationship between temperature and viscosity is inversely proportional for all substances. A change in temperature always affects the viscosity – it depends on the substance just how much it is influenced by a temperature change. For some fluids a decrease of 1°C already causes a 10 % increase in viscosity.

Temperature influence on viscosity:-1°C in temperature => +10 % in viscosity

Viscosity is another type of bulk property defined as a liquid's resistance to flow. When the intermolecular forces of attraction are strong within a liquid, there is a larger viscosity. An example of this phenomenon is imagining a race between two liquids down a windshield

Pressure

In most cases, a fluid's viscosity increases with increasing pressure. Compared to the temperature influence, liquids are influenced very little by the applied pressure. The reason is that liquids (other than gases) are almost non-compressible at low or medium pressures. For mostliquids, a considerable change in pressure from 0.1 to 30 MPa causes about the same change in viscosity as a temperature change of about 1 K (1°C).Even for the enormous pressure difference of 0.1 to 200 MPa the viscosity increase for most low-molecular liquids amounts to a factor 3 to 7 only. However, for mineral oils with high viscosity this factor can be up to 20000. For synthetic oils, this pressure change can even result in a viscosity increase by a factor of up to 8 million. For example, lubricants in cogwheels or gears can be submitted to pressures of 1 GPa and higher. For better understanding, refer to the conversion equation for pressure units: 1 bar = 0.1 MPa = 105 Pa = 105 N/m2

For most liquids, viscosity increases with increasing pressure because the amount of free volume in the internal structure decreases due to compression. Consequently, the molecules can move less freely and the internal friction forces increase. The result is an increased flow resistance. The Flow Behavior of Water under Pressure The anomaly that water has its maximum density at +4°C is widely known. Such an anomaly can also be observed for the flow behavior of water under pressure. For temperatures >+32°C, water behaves like other liquids. Its viscosity increases with increasing pressure. Below +32°C and under pressures of up to 20 MPa, the water's viscosity decreases with increasing pressure. The reason is that the structure of the three-dimensional network of hydrogen bridges is destroyed. This network is rather stronger than the structures of other low-molecular liquids. Factors Affecting Viscosity :A substance's flow behavior depends on three factors: The substance's inner - molecular – structure. The tighter the molecules are linked, the more the substance will resist deformation, i.e. the less it will be willing to flow.The outside or external forces acting upon the substance that deform it or make it flow. Both the intensity of the external force as well as the duration has an influence. Only Newtonian liquids are independent of the external force. The external force can have the form of wiping or pushing or tearing a substance; the simplest form is gravity, which pulls all substances down to earth. In viscometry, the external forces figure as shear rate or shear stress.The ambient conditions. The temperature and the pressure when the substance is stressed by external forces. Depending on these factors the substance flows and develops different types of flow. Only one type of flow is suitable for testing a substance's viscosity.

Fluids vs. Solids

In the above we have discussed the differences between the behaviour of solids and fluids under an applied force. Summarising,

a-For a solid the strain is a function of the applied stress (providing that the elastic limit has not been reached). For a fluid, the rate of strain is proportional to the applied stress.

b-The strain in a solid is independent of the time over which the force is applied and (if the elastic limit is not reached) the deformation disappears when the force is removed. A fluid continues to flow for as long as the force is applied and will not recover its original form when the force is removed.

Liquids vs. Gasses

Although liquids and gasses behave in much the same way and share many similar characteristics, they also possess distinct characteristics of their own. Specifically

- A liquid is difficult to compress and often regarded as being incompressible.

A gas is easily to compress and usually treated as such - it changes volume with pressure.

- A given mass of liquid occupies a given volume and will occupy the container it is in and form a free surface (if the container is of a larger volume).

A gas has no fixed volume, it changes volume to expand to fill the containing vessel. It will completely fill the vessel so no free surface is formed.

Causes of Viscosity in Fluids :

1. Viscosity in Gasses

The molecules of gasses are only weakly kept in position by molecular cohesion (as they are so far apart). As adjacent layers move by each other there is a continuous exchange of molecules. Molecules of a slower layer move to faster layers causing a drag, while molecules moving the other way exert an acceleration force. Mathematical considerations of this momentum exchange can lead to Newton law of viscosity.

If temperature of a gas increases the momentum exchange between layers will increase thus increasing viscosity.

Viscosity will also change with pressure - but under normal conditions this change is negligible in gasses.

Viscosity in Liquids

There is some molecular interchange between adjacent layers in liquids - but as the molecules are so much closer than in gasses the cohesive forces hold the molecules in place much more rigidly. This cohesion plays an important roll in the viscosity of liquids.Increasing the temperature of a fluid reduces the cohesive forces and increases the molecular interchange. Reducing cohesive forces reduces shear stress, while increasing molecular interchange increases shear stress. Because of this complex interrelation the effect of temperature on viscosity has something of the form:

Interesting Facts on Viscosity:

- When measuring viscosity with any type of viscometer, accurate temperature is so important that viscosity can double with a change of only 5 Celsius
- The viscosity of gases is approximately proportional to the square root of temperature
- Rheology is the study of viscosity

Compound: Olive Oil

Temperature	Viscosity
290.00	96.102
295.00	75.392
300.00	59.906
305.00	48.167
310.00	39.153
315.00	32.150
320.00	26.649
325.00	22.283
330.00	18.785
335.00	15.956
340.00	13.651

Table 1

High-Temperature Effects :

Fluid exposed to high temperature can experience permanent deterioration. For example, a substantial reduction in fluid viscosity normally accompanies asperity contacts (mechanical rubbing) and an increase in temperature. In addition, irreversible viscosity change can also occur when a fluid having poor shear stability encounters high temperature. Whether through rapid oil oxidation promoted by high temperature with its accompanying sludge formation production, or simply accelerated component wear, the influence of high temperature on oil properties is serious and generally deserves prompt consideration and attention.

The reduction in fluid viscosity is one of the most obvious effects of high-temperature operation. Viscosity decreases rapidly with increasing temperature because the mobility of the fluid molecules becomes hyperactive as gas is desorbed and lighter fractions of the fluid vaporize. Engineers commonly express the change in fluid viscosity with variations in temperature on an ASTM Standard Viscosity Temperature Chart. This particular chart is popular because the associated relationship tends to plot as a straight line. Deviations from a straight line most notably occur at both ends of the curve - at low temperatures where certain constituents of the fluid begin to revert to a solid phase, and at high temperatures where lighter fractions of the fluid vaporize. In general, measured values of viscosity are higher at lower temperatures and lower at higher temperatures. Consequently, engineers should extrapolate on ASTM charts with caution, keeping in mind the log2 nature of the viscosity axis.

Some fluids are very viscosity-sensitive with respect to temperature. To improve this situation, engineers commonly add polymers called Viscosity Index (VI) improvers. These improvers consist of long molecular chains which increase the VI of the blended oil over that of the base stock - that is, they flatten the viscosity-temperature curve.

Because the effectiveness of a VI-improved oil depends upon the chain length of the molecules, any breakdown, scission or shearing of these critical molecular bonds destroys an otherwise favorable viscosity characteristic of a VI-improved fluid. The high shear rates and turbulent flow conditions normally existing in fluid systems can cause a continual but often tolerable reduction in fluid viscosity.

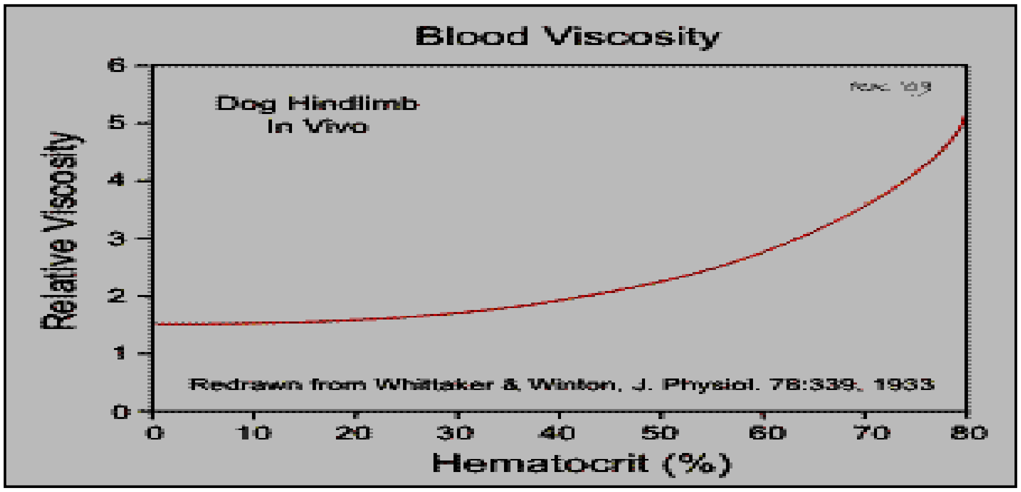
Blood Viscosity :

important factor that influences blood viscosity is temperature. Just like molasses, when blood gets cold, it get "thicker" and flows more slowly. Therefore, there is an inverse relationship between temperature and viscosity. Viscosity increases about 2% for each degree centigrade decrease in temperature. Normally, blood temperature does not change much in the body.

However, if a person's hand is exposed to a cold environment and the fingers become cold, the blood temperature in the fingers will fall and viscosity increase, which together with sympathetic-mediated vasoconstriction will decrease blood flow in the cooled region. When whole body hypothermia is induced in critical care or surgical situations, this will also lead to an increase in blood viscosity and therefore affect systemic hemo dynamics and organ blood flow.

Unlike water, blood is non-Newtonian, meaning that viscosity is not independent of flow at all flow velocities. In fact, during conditions such as circulatory shock where microcirculatory flow in tissues is reduced because of decreased arterial pressure, low flow states can lead to several-fold increases in viscosity. Low flow states permit increased molecular interactions to occur between red cells and between plasma proteins and red cells. This can cause red cells to stick together and form chains of several cells (rouleau formation) within the microcirculation, which increases the blood viscosity.

If clotting mechanisms are stimulated in the blood, platelet aggregation and interactions with plasma proteins occur. This leads to entrapment of red cells and clot formation, which dramatically increase blood viscosity.There is a microcirculatory phenomenon called the Fahraeus-Lindqvist effect that leads to a reduction in hematocrit in small arterioles (less than 200 microns in diameter) and capillaries relative to the hematocrit of large feed arteries. This decrease in hematocrit in these flow vessels reduces the relative blood viscosity in the small vessels, which helps to offset the increase in viscosity that can occur because of reduced velocity in these same vessels. The net effect of these changes is that blood flow in the microcirculation has a lower viscosity than what is predicted by in vitro blood viscometer measurements. In vivo measurements of blood viscosity were made in dog hindlimbs in 1933 by Whittaker and Winton (J. Physiol. 78:339, 1933). At a given arterial blood hematocrit, the relative viscosity of blood is much lower than predicted from in vitro experiments (compare figure at right with previous figure that used a viscometer).



Note : All these information are taken from reference in this review.

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