# History of brakes and principles of hydraulics engineering essay

Landing gears are one of the most important parts of the aircraft and play an important role because it can make the aircraft run through runways and lands the aircraft to safety with the aid of the braking system and other systems. The modern brake system has been refined for over 100 years and has become extremely dependable and efficient. The whole draft talks about the hydraulic brake system. Modern braking systems are complicated and understanding the operation of a braking system requires specialized skills and training. Brakes are the most important feature of any modern transportation these days.

The principles of brakes in a landing gear of the aircraft gave us the idea that making a simple hydraulic break system would be our main project. The content is designed to show the insight of the principles of operation of the hydraulic break, components and its functions. The advantages and disadvantages against different types of brakes and other terminology.

## : History oF Brakes:

All cars need a brake system; therefore it has been present in the automobile since its invention. However, the technology of the components and the design of the brake system have evolved throughout the years.

In the early days of the automobile, drum brakes were the standard. Drum brakes offered several advantages over other types of brakes. One of these was that the drum could keep out water and dust, materials that could damage disc brakes which were out in the open. The other, more important advantage was that drum brakes required drivers to apply less pressure on the pedal as compared to disc brakes. This was especially important in the

days before hydraulic and power brake systems, both of which decreased the amount of pedal pressure needed.

The next major advancement in brake technology came in 1918 with the invention of four-wheel hydraulic brake systems by Malcolm Loughead. It is interesting to note that Loughead was a member of the Lockheed family, a company known better for producing airplanes. The hydraulic brake system replaced the mechanical brake system that was in use at this time. The mechanical system had numerous disadvantages. It made it difficult to brake all the wheels evenly, often causing a loss of control. In addition, it required drivers to exert tremendous amounts of force on the brake pedal to slow the car. The hydraulic brake system multiplied the force that was applied to the brake, lessening the amount of force needed to be applied to the brake pedal by the driver. This system was first used in the 1918 Duesenberg. It's advantages quickly caught on and by 1929, four wheel hydraulic braking systems were standard equipment on most higher priced cars. It took a few more years for the feature to become common on lower price cars.

As the speed of automobiles and their weight increased, better braking systems were required. The main problem with drum brakes is that the heat is not efficiently disbursed. The heat that is produced inside the drum does not escape easily since the drum prevents wind from drawing it away. However, disc brakes were open to the passing wind. This allowed the heat to be carried away which increased the efficiency of the brake. It is interesting to note that disc brakes were first used in 1902. However, their use was limited up until the 1950's since their efficiency was not required and they required more pedal pressure to operate. The reason for the higher

pedal pressure is that disc brakes have no self-servo effect or no self-energizing capacity that the drum brakes have. The self-servo effect is caused by the forward motion of the car. This forward motion helps pull the brake shoe into contact with the drum. This helped lower the required pedal pressure. Now that their efficiency was needed and the hydraulic brake system multiplied the force applied to the brake pedal, disc brakes seemed to be the better alternative. Chrysler was the first to widely introduce the disc brake in its cars in the early 1950's. The system did not have much success. It seemed that the brake pressure required of the driver was still a little to great for the system to gain widespread consumer acceptance and therefore it was dropped. It finally took the failing automaker Studebaker to reintroduce the system in 1964. This time it saw much more success and in a few years, disc brakes were common on most new cars.

One of the reasons that disc brakes were a success with the Studebaker and not the Chrysler was due to the development of the power braking system. Power brakes became common in the 1950's, after Chrysler had developed and dropped its disc brake program. The system assisted the movement of the piston in the master cylinder which meant that the driver needed to apply less peddle pressure to get the same braking effectiveness. Therefore, since ease of braking was no longer an issue, the adoption of the more efficient disc brake became widespread.

Another development in braking systems came with anti-lock or anti-skid braking. With conventional braking systems, when the brakes are applied with enough pressure, the wheels will lock up. This results in a loss of steering effectiveness which may cause a loss of control. With anti-lock

braking, the wheels do not lock up, allowing the driver to continue steering. Anti-lock brakes are not a new technology. They had been used in large aircraft since the 1950's and the British had used them in race cars in the 1960's. The first automaker to use this technology in its cars was Ford in 1969. It placed anti-lock brakes in the luxury Thunderbird and Continental Mark III. Today, anti-lock brakes are common on many new cars.

## : Basic Principles of Hydraulics:

What is pressure?

Pressure can be defined as the force per unit area and is expressed in Newton's per square millimeter ($N/mm^2$) or in bars and pounds per square inch ($lbs/in^2$) or p. s. i. in U. S. pressure.

Formula: P = F / A Where: P = Pressure; F = Force; A = Area

What is hydraulics?

Liquids or fluids which are under pressure are usually used to transmit power through pipelines. The fluid power is converted into mechanical power by using rotary or linear actuators.

What is Pascal's Law?

Pascal's Law comprises a set of principles formulated in 1648 and states that pressure applied to a confined fluid at any point is transmitted undiminished throughout the fluid in all directions and acts upon every part f the confining vessel at right angles to its interior surfaces and equally upon equal areas.

It defines the fundamental principle of power transmission by a hydraulic system.

## Figure 2: Pascal's Law

Pressure is created only when:

The system is closed

There is no air trapped in the system

An attempt is made to compress the fluid

Another important relationship in hydraulics is the area of the piston, the distance it moves, and the volume of fluid displaced.

Formula: Volume = Area * Distance

## Fluid Compressibility:

All liquids have a very high resistance to compression while air has a very low resistance to compression. Liquids used in hydraulic systems are also known as hydraulic fluids.

## Figure 3: Hydraulic fluid

## Bramah's Press:

States that under a given load, the smaller the area it acts upon the greater the pressure produced and the greater the area under pressure, the greater the force available.

Pressure = Load / Area

## Figure 4: Bramah's Press

In an aircraft hydraulic system, Bramah's principle can be applied to the movement of different loads using actuators subject to one pressure. The figure above shows a large load and a small load being pushed by actuators having different piston areas.

## Bernoulli's Principle :

The relationship between the velocity and pressure exerted by a moving liquid is described by the Bernoulli's principle: as the velocity of a fluid increases, the pressure exerted by that fluid decreases and as fluid decreases, pressure is increased.

## Figure 5: Bernoulli's Principle

## Figure 6: Bernoulli's principle also allows wings to produce lift

## Hydraulic Fluids:

Hydraulic system fluid or liquids are used to transmit and to distribute the fluid to various units to be actuated. They are able to do this because they are almost compressible. If a number of passages exist in a system, pressure can be distributed to all of system by means of the liquid.

Manufacturers of hydraulic devices usually specify the type of liquid best suited for use with their equipment, during working conditions, the service required, temperatures expected inside and outside the systems, pressures the liquid may withstand, the possibilities of corrosion, and other conditions.

**Figure 7: Types of hydraulic fluid Figure 8: Hydraulic Fluid (Aeroshell brand)**

## Properties of Fluid:

Fluids are incompressible

They have a reasonable density with very little variation changes in temperature.

Low rate of change of viscosity with temperature changes

Large working range of temperature (-80°C to +70°C)

Good Lubricating Properties

It isn't harmful when in in contact (skin, hands)

It doesn't foam

Chemically stable with changes in temperature

Good storage life

Doesn't attack nor damage rubber.

Fluid is preferably non-flammable

## Efficiency:

Friction between the fluid and the walls of the pipes depends upon:

The velocity of the fluid of the pipelines

The bore, length and internal finish of the pipelines

The number of bends in the pipelines and the radii of the bends

The viscosity of the fluid

## What is Viscosity?

It is one of the properties of hydraulic fluid.

Viscosity is internal resistance to flow.

Viscosity increases with a decrease in temperature.

The knowledge of viscosity is needed for proper design of required temperatures for storage, pumping or injection of fluids.

There are two related measures of fluid viscosity - known as dynamic (or absolute) and kinematic viscosity.

## Types of Hydraulic Fluid:

1 - Vegetable Based: (MIL-H-7644) is composed of a caster oil and alcohol. It is dyed blue. They are mostly used in older type aircraft. Natural rubber seal are used with vegetable base hydraulic fluid. This type is flammable. And the system may be cleaned with the use of alcohol.

## Figure 9: Vegetable based fluid

2 - Mineral Base: (MIL-H-5606) it is processed from petroleum. It has an odour similar to penetrating oil and is dyed red. Synthetic rubber seals are used with petroleum base fluids. This type of fluid is flammable. They are used in common aircrafts and the precaution is damaging to rubber tyres.

## Figure 10: Mineral base fluid

3 - Synthetic Base: (MIL-H-8446) This is one of the most commonly used fluid of this type. This fluid is of a clear purple colour or either dyed green. They are fire resistant. The seal material used is synthetic butyl Teflon and the precaution is of damaging to surface finishes.

## Figure 11: Synthetic base fluid

These three types of fluids cannot be mixed nor any of them are compatible with each other.