International Journal of Mechanical Engineering and Research, ISSN 0973-4562 Vol. 5 No.1 (2015)

IMPLEMENTATION OF AEROGEL IN TWO WHEELER EXHAUST SYSTEM

S.Bhagavathi Shankar [1a], T.S.KirubaShankar [2b], V.Selvaraj [3c],

[1]Assistant Professor, Department Of Mechanical Engineering, V.S.B. Engineering College Karur -639111
[2]Assistant Professor, Department Of Mechanical Engineering, V.S.B. Engineering College Karur-639111
[3]Assistant Professor, Department Of Mechanical Engineering, V.S.B. Engineering College Karur-639111

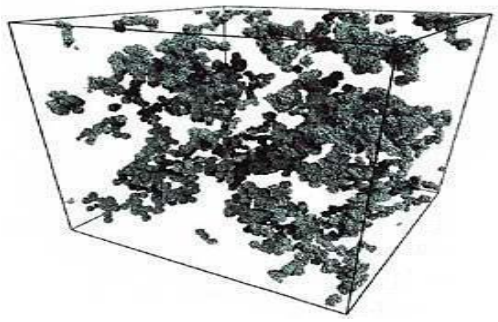
bhagavathi.mail@gmail.com[1a], reachkiruba@rediffmail.com [2b], sriselva01@gmail.com[3c]

Abstract— **Aim of the paper is to check the exhaust gas by providing a newly designed exhaust system using silica aerogel wherein the exhaust gases (except Hydrocarbons) are trapped on the surface of the highly porous gel which can be removed as harmful liquid acids by washing with water. The remaining gas namely O_2 and Hydrocarbons is reused again by connecting it the carburetor by using separate tubes, thereby taking advantage of their lower molecular weight. This will in turn increase the amount of combustion in the engine thereby increasing the engine power. The chamber also consists of pressure regulator and an exhaust gas sensor. The pressure regulator is used to prevent the system from high pressure situations and the gas sensors makes sure that the adsorption efficiency is high by detecting the amount of exhaustgascomingout.**

INTRODUCTION

The latest inventions of man in 20th century is aerogel which is considered to have extreme potential in terms of applications. **Aero gel** is a manufactured material with the lowest bulk density of any known porous solid. It is derived from a gel in which the liquid component of the gel has been replaced with a gas. The result is an extremely low-density solid with several remarkable properties, most notably its effectiveness as a thermal insulator and its extremely low density. It is nicknamed **frozen smoke solid smoke** or **blue smoke** due to its translucent nature and the way light scatters in the material; however, it feels like expanded polystyrene (styrofoam) to the touch. Aero gel was first created by Samuel Stephens Kistler in 1931, as a result of a bet with Charles Learned over who could replace the liquid in 'jellies' with gas without causing shrinkage. Theoretically, a block weighing less than a pound could support a weight of half a ton. Aerogels real strength is its incredible insulating effects on any kind of energy transfer; thermal, electrical or acoustic. Aerogel can damp out almost any kind of energy. A one-inch thick Aerogel window has the same insulation value as 15 panes of glass and trapped air - which means a conventional window would have to be ten-inches thick to equal a one-inch thick aerogel window. Silica-based aerogels are not known to be carcinogenic or toxic. The Process as follows: The mixed alcogels are placed in the autoclave (which has been filled with ethanol). The system is pressurized to at least 750-850 psi with CO2 and cooled to 5-10 degrees C. Liquid CO2 is then flushed through the vessel until all the ethanol has been removed. When the gels are ethanol-free the vessel is heated to a temperature above the critical temperature of CO2 (31 degrees C). As the vessel is heated the pressure of the system rises.

AEROGEL-CRYSTAL STRUCTURE AND PROPERTIES



When Stephen Kistler first discovered Silica Aerogel he found that one of the most extraordinary properties of Silica Aerogel was the extremely low thermal conductivity. He also found that the thermal conductivity decreased even more under a vacuum.

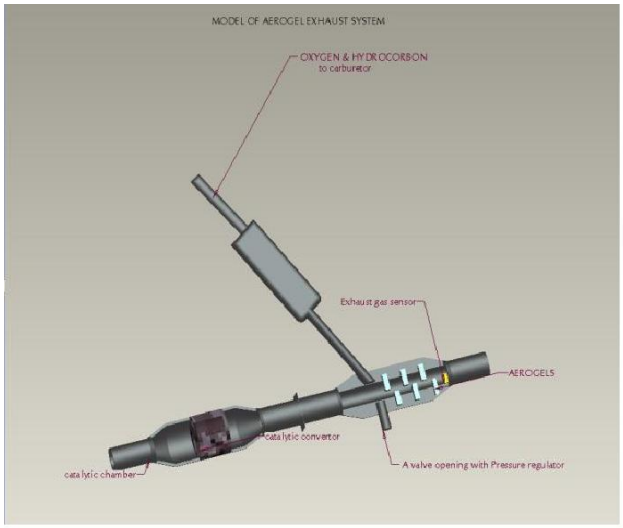
During the 1930's, when Kistler first discovered Aerogel, thermal insulation was a low priority and the use of Aerogel in insulation was not pursued. Around 1980 Aerogel technology coincided with an increased concern for energy efficiency. It was obvious that Silica Aerogels were a good alternative to traditional insulation due to their high insulating value and environment-friendly production methods. Unfortunately, the production costs of thematerial.

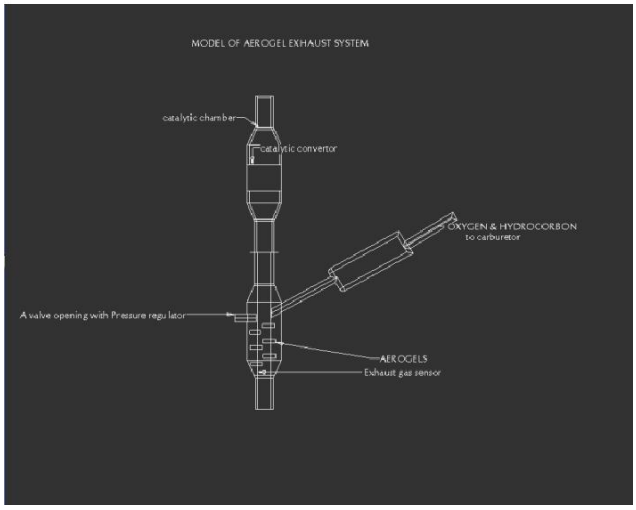
The passage of thermal energy through an insulating material occurs through three mechanisms; solid conductivity, gaseous conductivity, and radioactive transmission. The sum of these three components gives the total thermal conductivity of a material. Solid conductivity is a fundamental property of a specific material. For dense silica, solid conductivity is relatively high. A window pane transmits a large amount of thermal energy, however silica Aerogel possess a very small amount of solid silica. The solids that are present consist of very small particles linked in a three-dimensional crystal lattice with many dead ends. That makes thermal transport through the solid portion of silica Aerogel a very indirect path and not particularly effective. The space that is not occupied with solid silica is normally filled with air unless it is sealed under a vacuum. These gasses transport thermal energy through the Aerogel. The final mode of thermal transport through silica Aerogel involves infrared radiation. An advantage of Aerogel for insulation purposes is their transparency which would allow their use in windows and skylights, but they are reasonably transparent in infrared. At low temperatures, the radioactive component of thermal transport is low. At higher temperatures, radioactive transport becomes the dominant mode of thermal conduction. Attempting to calculate the total thermal conductivity from these three components can be difficult because they are coupled with each other. For example changing the infrared absorbency changes the solid conductivity. It is easier to measure the total thermal conductivity rather than trying to predict the effect of changing one component. The lab at Berkley University designed and built an instrument for measuring thermal conductivity for large panels of Aerogel. The Vacuum Conductivity Tester on Rollers or VICTOR is a thin-film heater based device that can measure the thermal conductivity of Aerogel panels with pressures of various gasses.

There is not much that can be done to reduce thermal transport through the solid part of silica Aerogel, except by making it less dense, which reduces the amount of solid present. The problem with this is it makes the Aerogel mechanically weaker. The radioactive component of thermal conductivity becomes more important as the temperature increases. If Aerogel is to be used at a temperature above 200 degrees Celsius, this mode of energy transport must be suppressed. This can be accomplished by adding an additional component to the Aerogel. The component must either absorb or scatter infrared radiation. Elemental Carbon is an effective absorber of infrared radiation and actually increases the mechanical strength of the Aerogel. Silica Aerogel is the lightest solid on the planet and has the greatest thermal conductivity of any material. There are many practical uses for Aerogel because of its thermal properties. Sometime in the near future Aerogel could find its way in to the insulation of every household. Aerogel have been around for quite a while, but only recently has technology enabled the innovative product to be produced commercially and cheaper than ever before.

DESIGN OF AEROGEL EXHAUST SYSTEM

As shown in the figure below, the design of aerogel system consists of a separate chamber which is similar to catalytic converter and is connected to the later. The shape of the chamber is in the form of convergent-divergent nozzle. The construction of aerogel chamber consists of array of aerogel placed in a zigzag manner to trap the gases coming through the chamber. The chamber also consists of three tubes of which one of them is connected to the carburetor and the remaining two to the atmosphere. The first tube connected to the carburetor has a timing valve. The second tube has a pressure gauge and the third one consists of exhaust gas sensor.





After the exhaust stroke, the gases are passed through the catalytic converter where the gases are reduced to a considerable extent. But since only a part of gas is reduced, the gases coming out from the catalytic converter would still consist of very harmful gases in CO, , NO_x, CH_3NO_2, unburnt hydrocarbons etc., coming out. So, the paper deals with the elimination of these harmful gases and in the same time improve its efficiency. Chamber is made flexible so as to separate it from the system whenever required.

WORKING OF EXHAUST GAS SYSTEM

After the gases are passed through catalytic converter, the valve to carburetor is opened by using timing valve for a few

seconds. Since the weight of Hydrocarbons is very less compared to the other gases, the unburnt hydrocarbons are sucked by the tube. After the tube is closed, the rest of the gases are passed through an array of aerogel. The gases are adsorbed on the surface of aerogel due to its extremely porous surface. Then the minimum amounts of gases escaping the gel chamber are passed through the outlet valve at the end.

Among the gases adsorbed by the aerogel,

1) CO_2, NO_x is reduced to liquid acids by passing water through the chamber.

2) CH_3NO_2 is reduced to CO_2 and N_2 by exposing it to oxygen.

3) CO can be reduced by heating in presence of oxygen to CO_2, thereby reducing it further to water.

4) The remaining minor amount of less harmful flue gases escapes to the atmosphere.

The reactions are:

ADVNATAGES OF THE SYSTEM

- The main advantage is that the design makes use of unique properties of aerogel. Aerogel has changed the world of insulation. It began as a brittle substance with very good insulation properties and ended up as one of the most light-weight and flexible materials known to man. Aerogel represents one of the most innovative technological advances the world has ever seen. It started as a brittle, useless substance but eventually was transformed into flexible, innovative materials that can be manufactured. As the Aerogels are seen everywhere there is a need for extreme thermal protection, maybe in the future it will be seen in automobiles, homes, and clothing for a price not much more that what is paid for the general insulation used today. Also, the setup makes sure that
- $CO_2 + H_2O \rightarrow H_2CO_3$
- $NO_x + H_2O \rightarrow H_2NO_3$
- $4CH_3NO_2 + 3O_2 \rightarrow 4CO_2 + 6H_2O + 2N_2$
- $CO + ½\ O_2 \rightarrow CO_2$

Also, the timing valve in the tube to carburetor enables to let only the HC to pass through. The pressure regulator is provided in the chamber to release the gases in case of excess pressure formation. At the end of the chamber, exhaust gas sensor is provided to keep in check the amount of gases passing out. none of harmful gases is exposed to the atmosphere. And in addition to that the efficiency of the engine is increased by the passing of the unburnt hydrocarbons back to the carburetor. Also it should not be forgotten that the costs of the specific materials used to make Aerogel including methanol, sodium silicate, resorcinol and more. Today the cost of the raw materials has decreased due to technological advances. To be specific, Aerogel costs, such as sodium silicate costs $0.63 per board foot and Resorcinol runs $1.34 per board foot. Also, the gases coming out after passing the absorbents through water consist of nitrogen which is a very important gas for the plants. Also, the liquid chemicals formed can be reused in different ways. So, in this system no harmful gas comes out.

CONCLUSION

Almost completely, the impact of this exhaust gas elimination will be very high due to fact that vehicle emission accounts for a high percentage of harmful gas (**greenhouse gas**) released. Since, all the harmful gases are converted into either water or oxygen, this type of installing a catalytic converter with the array of aerogel pack is very useful to the industry to reduce emissions.

This method can also allow the unburnt hydrocarbons to get back to the engine system for the next combustion process. So all fuels can burn fully and the chemical reaction can takes place effectively which in turn converted into mechanical reaction and improves the efficiency of the engine.