

# The Swelling Physical Effect on Rubber

<sup>1</sup>Doaa Shrafeldeen Ibrahim Abdelrhman , <sup>2</sup>Amel Abdalla Ahmed Elfaki & <sup>3</sup>Sawsan Ahmed Elhourri Ahmed

<sup>1,2</sup> Sudan University of Science & Technology-College of Science  
Department of Physics- Khartoum-Sudan

<sup>3</sup>University of Bahri -College of Applied & Industrial Sciences  
Department of Physics -Khartoum -Sudan

## Abstract

In this work, two samples of rubber were studied. The samples were the internal and external layers of cars tire. The two samples were placed in gasoline, acetone and benzene glass cups at different time periods. A physical effect was noticed; both samples were swallowed; as a result their weight changes dramatically.

The percentage of carbon black in the internal layer of the tire is lower than the external layer. It is found that the swelling property was higher in benzene when the percentage of carbon black is high.

## Introduction

The swelling process is by definition an increase in the volume of a gel or solid connected with uptake of a liquid or gas. The absorption of liquids lead to changes in the mechanical properties of the swollen material and may create extra pressure when it occurs in confined spaces which results in various deformation of the swollen material [1].

## Material and Methodology

Gasoline, acetone and benzene were placed in glass cups the samples of different rubbers were weighted before placed in the solvents, then three pieces of rubber were placed in the different solvents for period 2 hours, the samples were weighted again, the experiment has repeated at (2,3,4) hours to observe the swelling as shown in table below.

### i. Materials

\***Rubber:** Natural rubber (NR) is occurs in Hevea rubber trees. NR tapped from other rubber trees is the transisomer of polyisoprene. NR's principal uses are automotive tires, tire tread and mechanical goods. Automotive applications are always compounded with carbon black to impart UV resistance and to increase mechanical properties [2].

### Solvent

\***Gasoline** is a complex manufactured mixture that does not exist naturally in the environment. Gasoline is produced from petroleum in the refining process. Physical properties of gasoline molecular weight = 108, color is pale brown, physical state is liquid and density = 0.7 to 0.8 [3].

\***Acetone:** Acetone is a colorless liquid with a distinct smell evaporates readily into the air and mixes well with water. Physical properties of acetone molecular weight = 58.08, colorless, physical state is liquid and density = 0.78 [4].

\***Benzene:** Benzene is liquid highly flammable and evaporates into air very quickly and dissolves slightly in water. Physical properties of benzene molecular weight = 78.11, color is yellow, physical state is liquid and density = 0.8787 [5].



Figure (1): the samples of rubber

**ii. Theorem**

$$W = W_g - W_0$$

$$W = W_a - W_0$$

$$W = W_b - W_0$$

Where

W: Net weight

$W_0$ : Initial weight

$W_g$ : Weight in gasoline

$W_a$ : Weight in acetone

$W_b$ : Weight in benzene

**iii. Results**

Table (1): The result of rubber of high percentage carbon black

$W_{0g}=2.7929g$		$W_{0a}=2.8019g$			$W_{0b}=3.7779g$	
Time/hours	$w_g(g)$	W(g)	$w_a(g)$	W(g)	$w_b(g)$	W(g)
2	3.1657	0.3728	3.0027	0.2008	4.9090	1.1311
3	3.2660	0.4731	3.1187	0.3168	5.3499	1.572
4	3.3265	0.5336	3.1189	0.317	5.436	1.6581

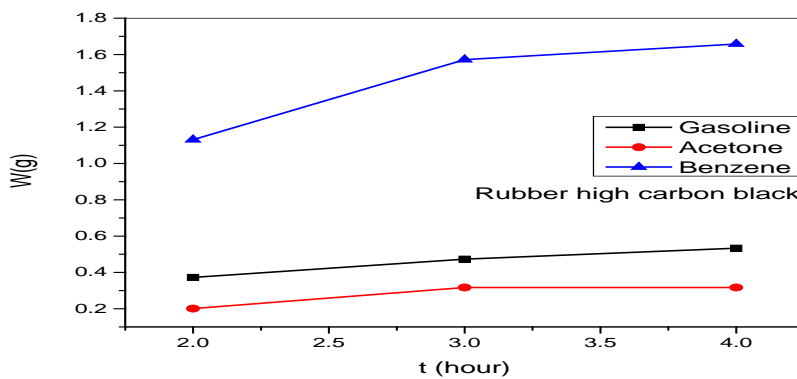


Figure (2): shows the result of rubber of high percentage carbon black

Table (2): the result of rubber of low percentage carbon black

W <sub>0</sub> =0.9632g						
Time/hours	w <sub>g</sub> (g)	W(g)	w <sub>a</sub> (g)	W(g)	w <sub>b</sub> (g)	W(g)
2	1.0967	0.1335	1.0312	0.068	1.2960	0.3328
3	1.1335	0.1703	1.0530	0.089	1.3130	0.3498
4	1.2051	0.2419	1.0619	0.0987	1.3212	0.358

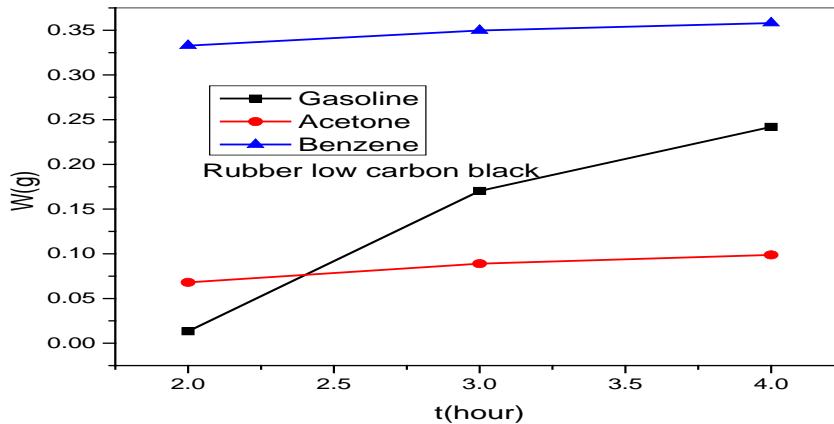


Figure (3): shows the result of rubber low percentage carbon black

**Conclusion and Discussion**

Tables one and two show high swelling in benzene then gasoline and acetone respectively, also samples weight increased significantly after two hour in benzene this is due to the similar structure of rubber. Benzene and gasoline as they are all hydrocarbons interact with each other more than other compounds. The bonds are dissolved in the rubber by the butane gas in benzene and gasoline thus the solvent is absorbed in the polymer and thus increases the weight.

The swelling have great impact on rubbers especially at high carbon black percentage it can swell at short immersed time.

**References**

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