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Enhancement Mechanical Properties of Some Cosmetics and Their Effect on Human Skin by Ultrasonic Technique

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Abstract
Some physical properties were studied such as density, velocity, absorption coefficient, relaxation amplitude, compressibility, modulus of elasticity, and acoustic Impedance for four types of cosmetics available locally before and after added polymer CMC for these cosmetics the results show that the addition of CMC polymer led to improve these properties, except compressibility decreased due to the addition of polymer, so we can deduce that the addition of polymer leads to improve the characteristics of cosmetics practically .
Keywords: Carboxy methyl cellulose**;** Cosmetics; Mechanical properties; Ultrasound technique

1. Introduction:

Cosmetics are including skin creams, lotions, perfumes, makeups, hair preparations, deodorants and others [1]. Food, drug and cosmetics regulatory authorities encourage cosmetic makers to do whatever tests are needed to prove whether their cosmetics are safe. Nevertheless, cosmetics makers can sell products without the authorities' approval. In addition, a cosmetic manufacturer does not have to report injury from its product and they can add any ingredient to beautify their brand without any approval. This set up expose consumers to suffer from adverse effects of cosmetics [2]. Currently, cosmetics, due to their multiple ingredients, are the top causes of toxicity exposure [3]. To compensate this, cosmetics consumers are highly recommended to follow some safety tips. These include reading ingredients on the labels, not to share cosmetic products, utilize hygienically, to consume products with fewer ingredients, to buy from right source and others. Generally, care to get the maximum benefits from cosmetics fall on the hands of consumers [4]. The problem is most of the cosmetic users are not seriously concerned about the effect of usage of products to their skin. Instead, they focus on the short-term result to their skin appearance rather than the long-term effects to the whole body. Studies indicated that quite a large number of cosmetic users were threatened with terrible result but still continued using the product in order to satisfy their egoistic needs [5]. To come up with this problem FDA has established a network system for the sake of gathering consumers' complaints. Likewise, European countries have designed a project intended to collect information on cosmetics utilization pattern, so that they can use the information as an input for hazard assessment [6]. Similarly, Cosmetics, Toiletry and Fragrance Association have donated different institutions to conduct risk assessment studies. Through this technique, more than nine cosmetic ingredients were reviewed to be unsafe, though their usage is not ceased[7].

CMC is one of the most important cellulose derivatives, which have an immense importance to the industry and also in our everyday life. CMC is a linear, long chain, water soluble, anionic polysaccharide derived from cellulose. In addition, the purified cellulose is a white to cream colored as well as tasteless, odorless, and it is a free-flowing powder. CMC is an important industrial polymer due to its high viscosity, non-toxic, non-allergenic, biodegradability as well as production at lower cost, Furthermore; it is a most important water soluble derivative with various applications in paper, food, detergents, cosmetics, and textiles [8]. CMC is water – soluble synthetic polymers. CMC is used primarily because it has high viscosity, it is non-toxic, and is non-allergenic. CMC has a wide range of applications due to its low cost [9] Because of its polymeric structure and high molecular Wight; it can be used as filler in bio- composite films [10].

In our study we adding CMC to four types of cosmetics under stnrly to improve their physical properties and to reduce their disadvantage effects on the skin.

2. Experimental:

2.1Material used

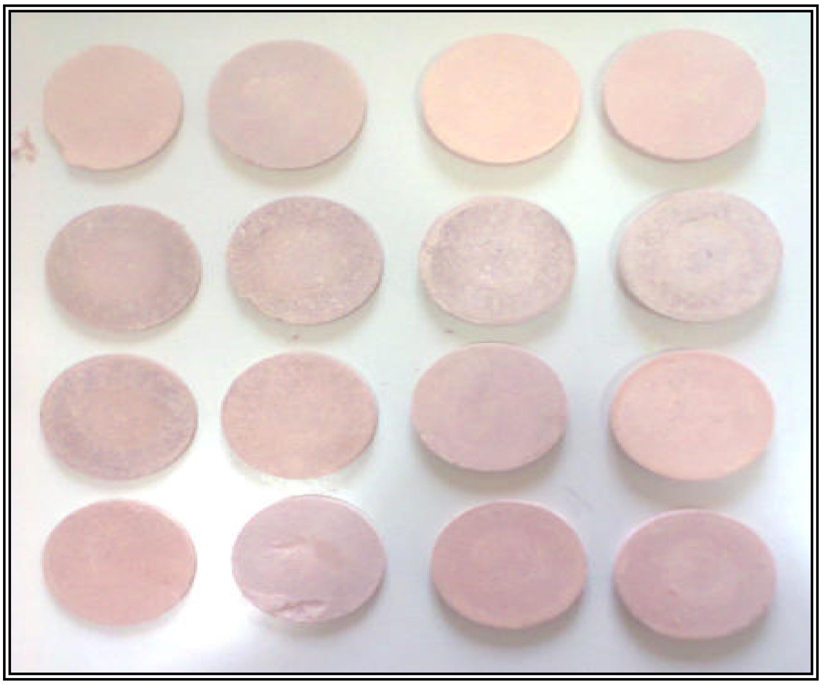
We used four types of cosmetics available in the market which their symbols are X, Y, Z, W and following table shows their contents.

Table (1) the material under study .

type	Product name	Components	Manufacturer
X	Kokuryu super summer cake	Mineral Oil, propylene glycol monostearate, lanolin , petrolatum, triethanolamine , butyl paraben, tocopherol acetate , titanium dioxide , kaolin ,talc power, perfume, allantoin power, iron oxide (red- yellow- black), D & C blue No. 4.	Philippines
Y	Green tea (natural press face powder)	Green tea extract, talcum powder, mica powder, kleit, zinc dioxide, starch, titanium dioxide, MP, PP, BHA, silicone oil, white mineral oil.	Shantou Tingji cosmetics
Z	Just Gold	Talk, mica, dimethicone, BIS-diglycerly polycyladipate-2, petrolatum, titanium dioxide, methyl paraben, propyl paraben, manganese violet, ultramarine blue, iron blue, iron oxide (red-yellow- black), FD & C yellow 5 allake, FD & C blue 1 allake, FD & C red 40 allake, D & C red 27 allake.	PRC
W	Multi-Way (compact powder)	Talk, magnesium carbonate, zinc stearate, zinc oxide, liocotyl stearate, silica, parfum, camelica sinagla, tocopheryl acetate, squalance, methyl paraben, BHT, propyl paraben, iron oxide (red-yellow- black),inmdiaxo lidinyl urea.	PRC

2.2 Sample Preparation:

We took different weights of each cosmetics ranging from (5, 8, 11, 14 gm.), using an electronic balance of accuracy (± 0.0001 gm.) by butting these samples under pressured (50 KN) for (20) minutes. And then the samples were obtained in the form of a disc with 4 cm diameter with different thickness ranging about (2.48 – 5.56 mm). And then added (0.6 gm.) of CMC for all thickness**.** The picture below shows the form of the samples resulting for four types of cosmetics.



2.3 Ultrasonic Measurements:

Ultrasonic measurements were made by pulse technique of sender-receiver type (SV-DH-7A/SVX-7 velocity of sound instrument) manufactured by Korea shown in fig.(2) with constant frequency (30 KHz), the receiver quartz crystal mounted on a digital vernier scale of slow motion, the receiver crystal could be displaced parallel to the sender and the samples were put between sender and receiver. The sender and receiver pulses (waves) w... s were r... presents i... receiver u...

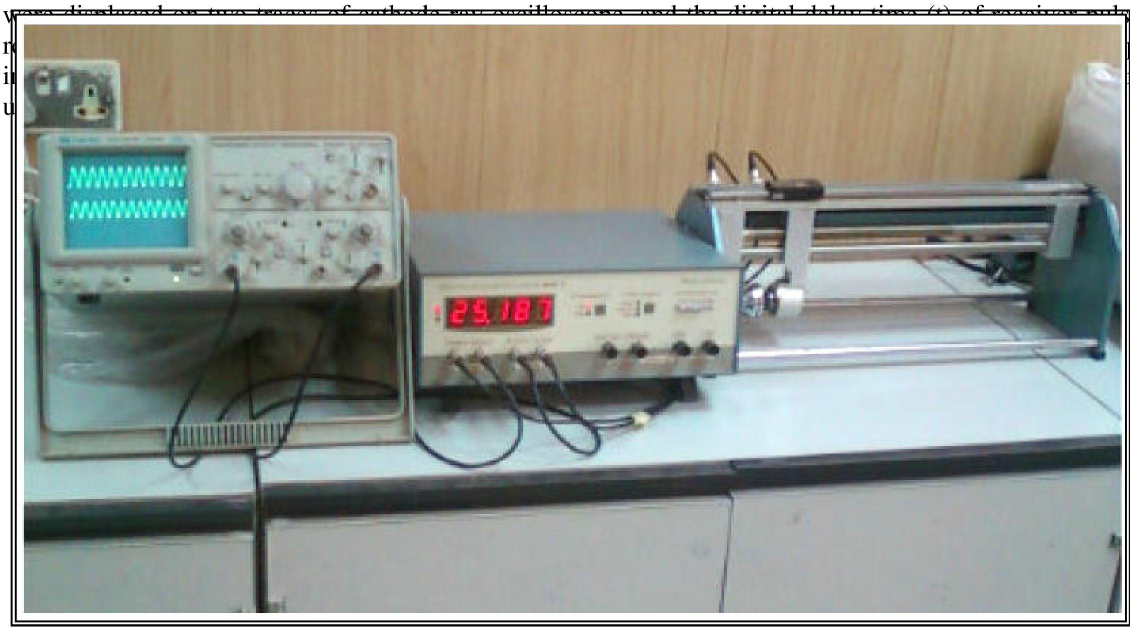


Fig. (2) Generator and Receiver of Ultrasonic Waves.

2.4 Theoretical calculations:

The ultrasound wave velocity (V) was calculated using the following equation [11]:

$$V = X / t \;\ldots\ldots\; (1)$$

Where X is composite thickness and t is time delay of pulse.

Compressibility (β) is a measure of the relative volume change of a fluid or solid as a response to a pressure (or mean stress) change, it was calculated by the following Laplace equation where (ρ) is the density [12]:

$$\beta = (\rho\, v^2)^{-1} \;\ldots\ldots\; (2)$$

Bulk modulus (K) of a composite is the substance's resistance to uniform compression, it is defined as the pressure increase needed to decrease the volume; it was calculated by [13, 14]:

$$K = \rho\, v^2 \;\ldots\ldots\; (3)$$

The acoustic impedance of a medium (Z) was calculated by equation[15]:

$$Z = \rho\, v \;\ldots\ldots\; (4)$$

Absorption coefficient (α) was calculated from Lambert – Beer law [16]:

$$A/A_o = e\,(-\,\alpha\, x) \;\ldots\ldots\; (5)$$

Where (A_o) is the initially amplitude of the ultrasonic waves,(A) is the wave amplitude after absorption and (x) is the thickness of the sample. Attenuation is generally proportional to the square of sound frequency (f) so the relaxation amplitude (D) was calculated from the following equation [17]:

$$D = \alpha / f^2 \;\ldots\ldots\; (6)$$

Transmittance (T) is the fraction of incident wave at a specified wavelength that passes through a sample was calculated from the following equation [18]:

$$T = I / I_o \;\ldots\ldots\; (7)$$

3. Results and discussions:

The densities of four cosmetics/CMC composite types have been measured by the weight method at room temperature (296.15 K.), figure (3) shows that the density of the composite increases because CMC molecules occupied the vacancies between powder molecules displcing molecules from their positions and since density is mass per unit volume so increasing the density with increasing the concentration[19].

Ultrasonic velocity is increasing with increasing of cosmetic thickness as shown in (Fig.4) this because when waves are propagated through it, the resultant periodic changes of wave pressure causes molecules to flow into vacancies in the lattice during compression phase and to return to their original positions in the lattice during rarefaction so when concentration increases the velocity is also increase [20].and Adding CMC increase the velocity, this attributed that ultrasonic waves interact with cosmetic and CMC molecules causing association between the two types of molecules that lead to increase the velocity [21].

(Fig.5) shows that absorption coefficient is increasing with thickness this attributed to the fact that when of ultrasonic waves thickness increase there will be more molecules in composite this lead to more attenuation against wave propagation, the attenuation can be attributed to the friction and heat exchange between the particles and the surrounding medium as well as to the decay of the acoustic wave in the forward direction due to scattering by the Particles , this behavior same to that give by other polymers [22,23], adding CMC enhances absorption coefficient by increasing its values. The relaxation amplitude are increasing with thickness as shown in figure (6) since it depend on the absorption coefficient as related in equation no (6).

Figure (7) shows that the compressibility are decreasing with increasing thickness this could be attributed that ultrasonic waves propagation made polymer chains that randomly coiled to be each close together, this change configuration of these molecules, so there are more compression happen of these molecules through ultrasound wave propagation [24,25] the compression fills the vacancies between powder molecules and restricted the movement of these molecules this lead to reduce the elasticity of the composite as shown in figure (5) And the bulk modulus is increasing with thickness (Fig.8) ; this behavior same to that give by [26]. Specific acoustic impedance shown in (Fig.9) is increasing with thickness attributed to the equation no. (4) has only one variable parameter which is velocity and density has very small variations with respect to that of velocity [27].

Most of cosmetics composed mainly of magnesium oxide (MgO) and (SiO_2) this article is used to eliminate of sweat and also used to prevent the skin irritation after have [28] so the skin will be dry we retain the skin moisturize by adding CMC polymer to the cosmetics because CMC swell the sweat or water making the skin always not dry. Cosmetics such as foundation contain mineral oil which sits on the skin surface and can potentially block pores; this may cause the appearance of pimples because the skin cannot properly breath [29] so we avoid this by adding CMC polymer to cosmetics which swell sweat from skin because this polymer is hydrophilic polymer [30] then its molecules becomes layer than before adding so prevent mineral oil to block the pores keeping the skin breath. This agree with bulk modulus results shown in fig.(9) it is clear that adding CMC increasing bulk modulus that means increasing moisturized for skin.

Conclusion:

1. The density increased after adding CMC polymer which make composite to be good for protect skin from environment.
2. Adding CMC polymer euhances the skin mosturize because it is hydrophic polymer donot dry the skin.
3. Adding CMC polymer improve the flexibihty of the skin by increasing its mosturize.
4. Adding CMC polymer prevent mineral oil blocked skin pores because of its high flexibilrty as a result of its absorbance of sweat .that make its molecules as macromolenes chang because of sweat swelling.
5. this composite has good mechanical properties so it may use as resistant materials against environment.

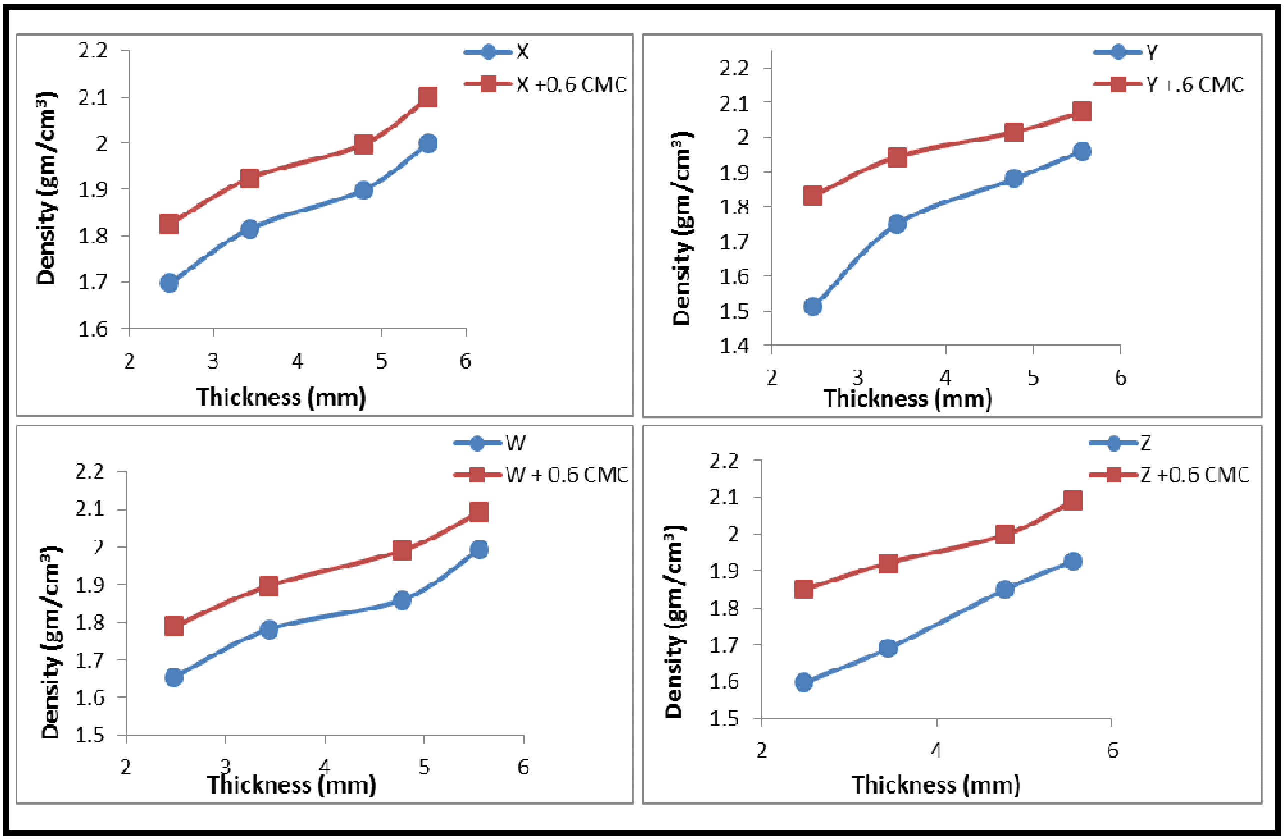


Fig. (3) Density due to thickness of four types of cosmetics.

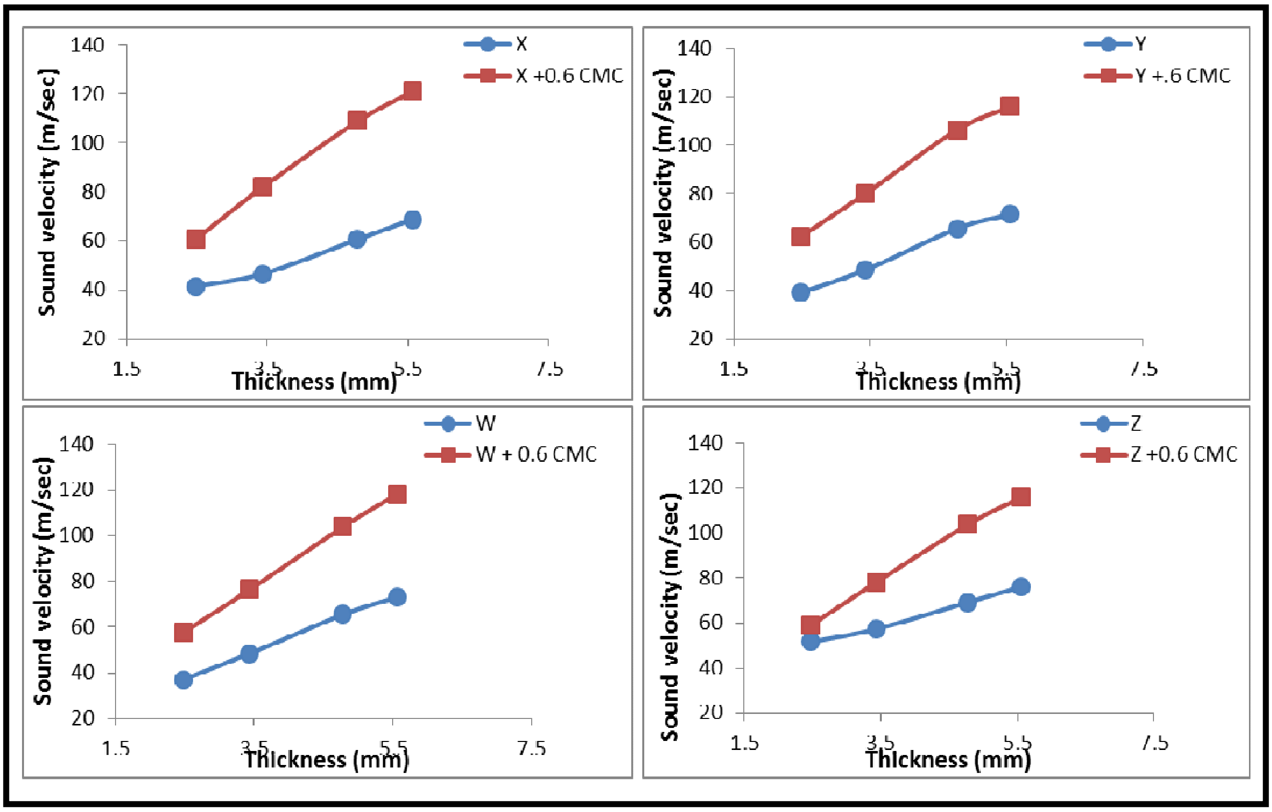


Fig. (4) Velocity of sound due to thickness of four types of cosmetics.

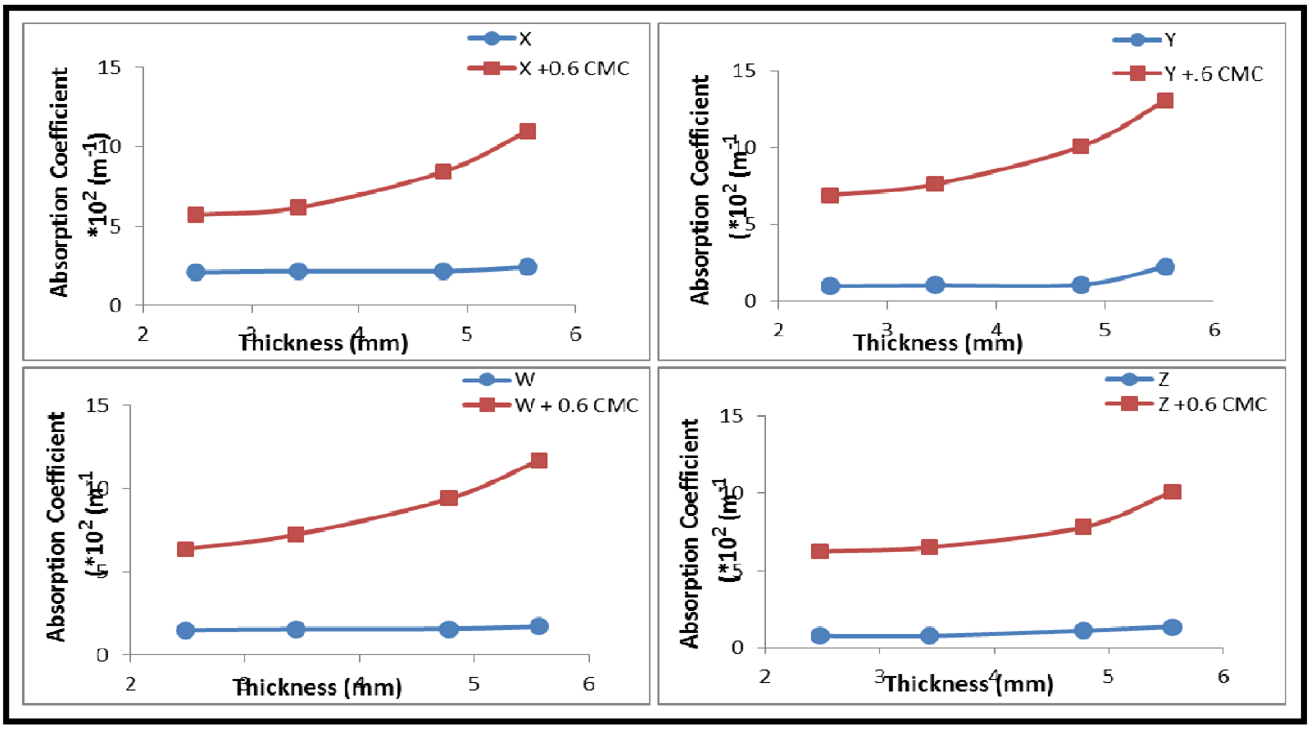


Fig. (5) Absorption coefficient due to thickness four types of cosmetics.

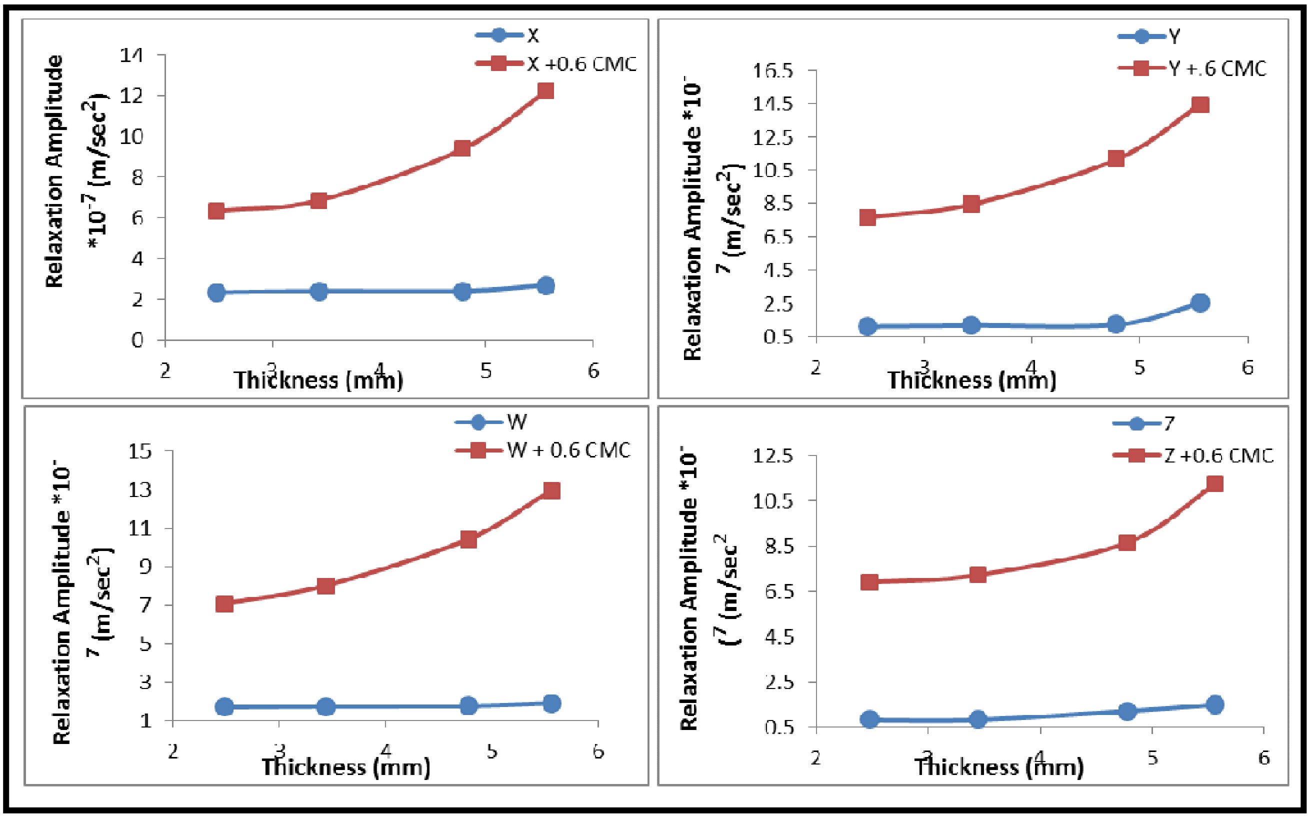


Fig. (6) Relaxation amplitude due to thickness of four types of cosmetics.

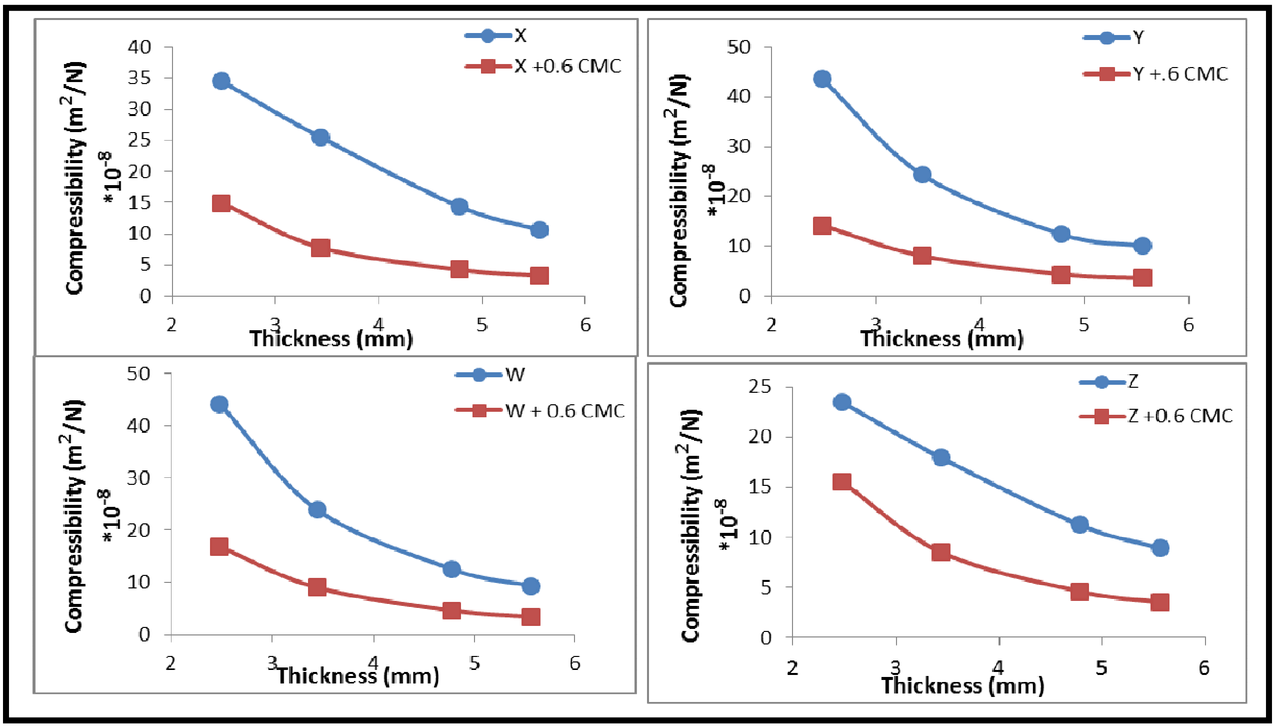


Fig. (7) Compressibility due to thickness of four types of cosmetics.

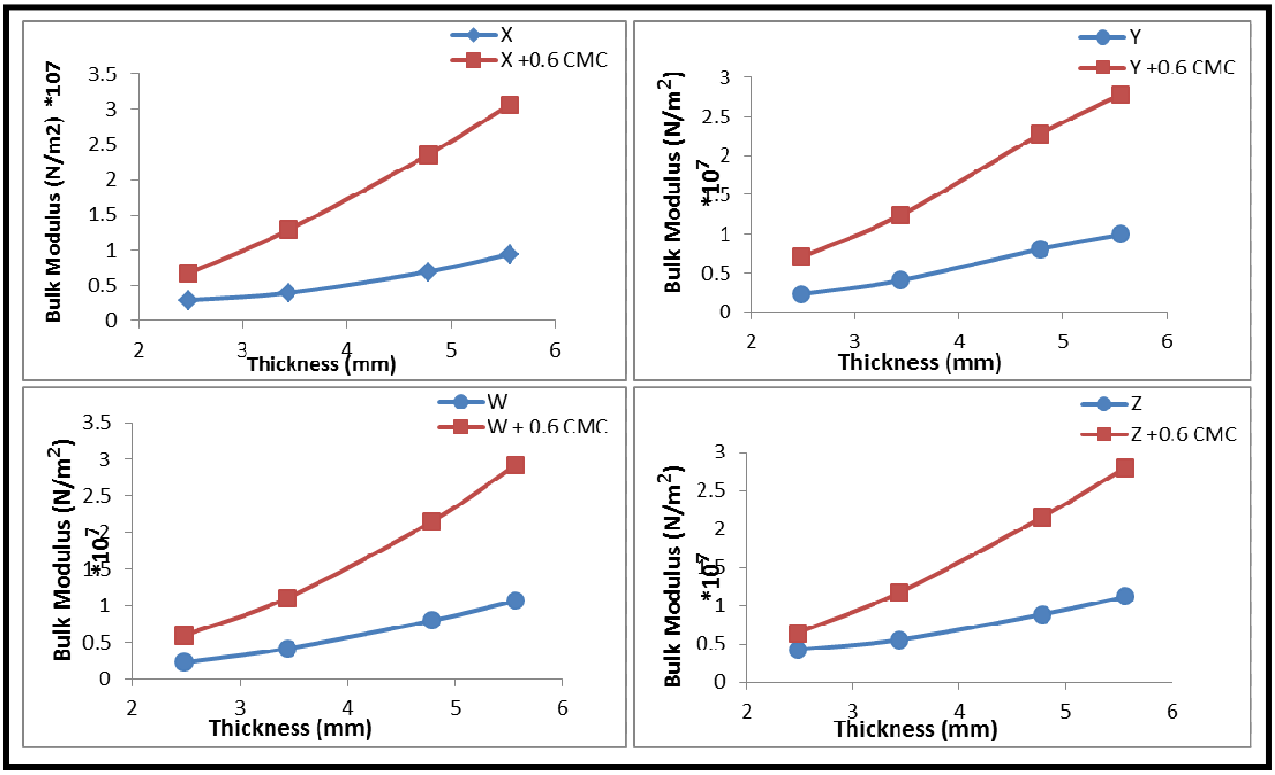


Fig. (8) Bulk modulus due to thickness four types of cosmetics.

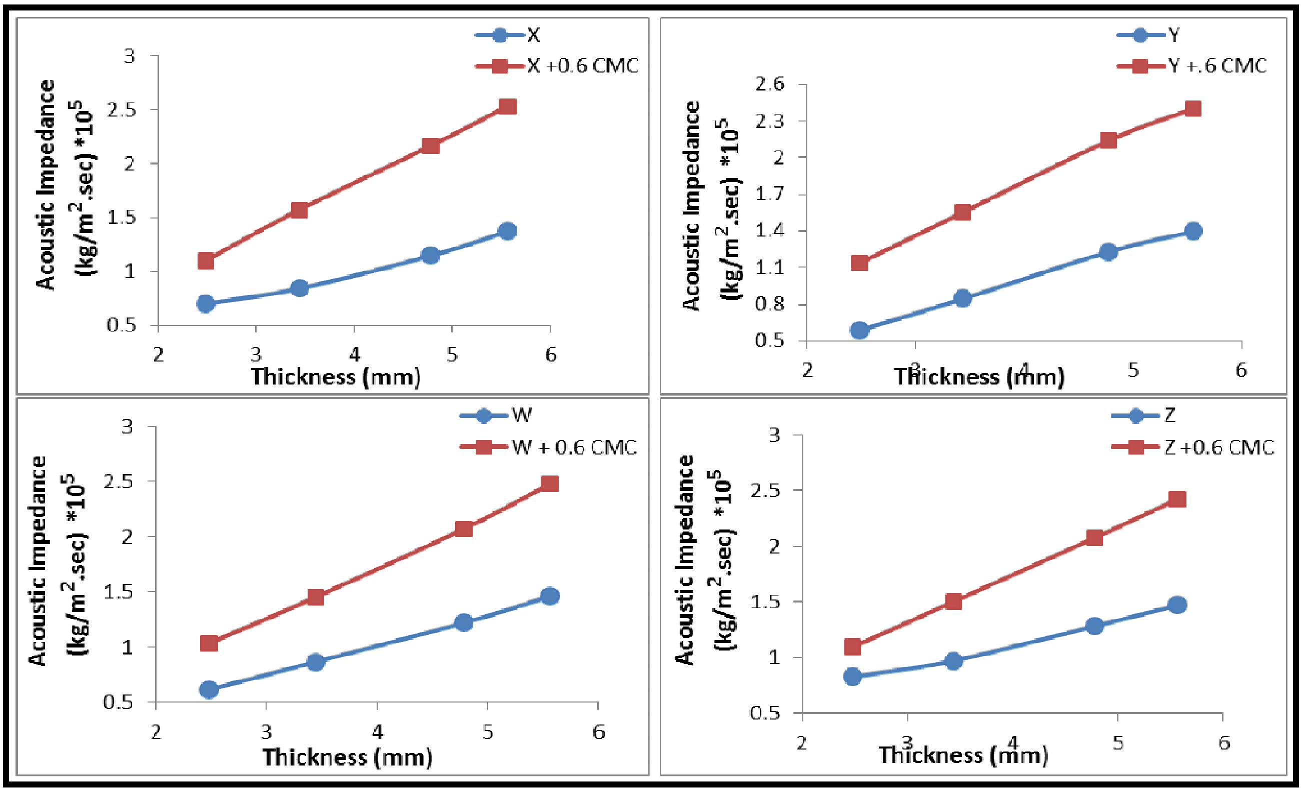


Fig. (9) Acoustic impedance due to thickness of four types of cosmetics.

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