International Journal of Thales Engineering Sciences (JTHES)
ISSN (print): 2149-5173

The Effects on Heat Saving of Lightweight Aggregate Based on Pumice

Hüseyin Güllüce
Atatürk University

Ferhat Kaya
Atatürk University

Ahmet Numan Özakın
Atatürk University

Süleyman Karsli
Atatürk University

ABSTRACT

In building construction substantially natural materials are used. The pumice is a very important building material which used as a lightweight aggregate. The pumice production costs are lower than the brick production costs. Because there isn't cooking process in the pumice production. Therefore both its production is more economical and the pollution potential of it is low. The low thermal conductivity coefficient of this material provides energy saving considerably. In this research, it was analyzed the heat insulation specifications of the pumice materials and the pumice configuration addition plaster and lime. For these pumice configurations, thermal conductivity's effect on energy savings was investigated.

Keywords: Energy saving, energy importance, energy.

1 INTRODUCTION

Pumice is a lightweight aggregate which silicate based, porous, spongy, physically and chemically stable, has the max. density of 1 gr/cm³, glassy, acidic and basic character formed as a result of volcanic activity and a igneous rocks. Its formation is the result of the solidification of magma in the earth or quite close to the earth. Pumice contains plenty of gas space and the space are usually not interconnected. So when thrown into the water don't sink to the bottom [1]. Acidic pumice which is most commonly found in the ground and white colored. Basic pumice is the blackish color. Acidic pumices silica content is higher, there is widely used in the construction industry. Pumice of basic character has aluminum, iron, calcium and magnesium components at a higher rate so It is find use in other industrial. During the formation both types of pumice so that the rapid cooling and the sudden discharge of gas they are porous. Pumice may vary according to the location and can also vary within each region its own.

In the pumice briquette production using cement and water with the pressure and vibration machines poured into molds and dried. Drying pellets are subsequently used in wall construction. Another building element the brick is after being manufactured it is firing in the kilns. This situation leads so much energy consumption for manufacturing. In the briquettes manufactured with pumice is no need for heat. Because of bigger sized briquettes both increases the construction speed and saves labour and time. It also reduces the weight of the building and reduces inertial forces that cause harmful effect in earthquakes.

Pumice, also provides thermal and sound insulation. It provides heat and moisture balance in buildings and has benefit in preventing condensate.

Studies on pumice and similar materials are continues all over the world. Thanks to improvements in this regard use of pumice will increase as a building material. In our country, the population is 35.6 million in 1970 and total energy consumption is 16496 TOE. The sectorial distribution of its 52% residential, 25% in industry, 19% in transport and 3% in agriculture. These values formed recently; population is approximately 73 million, and energy consumption 73460 TOE. The sectoral distribution of its 32% residential, 42% in industry, 20% in the form of transportation and agriculture 5% [3,4].

Building construction materials are supplied from sources in the region. The materials obtained from outside the local area are causes production and shipping costs. Density of insulation material is low and the volume is high so the transport costs increases. The use of building materials in the region should be preferred to have fewer expenses. This will benefit both the local development and employment. With the energy saving the pollution value will decrease and the foreign currency savings will be provided [9].

In this research with different additives pumices conductivity values were investigated.

2 MATERIALS AND METHODS

Chemical analysis of pumice used in the experiments are given in Table 2.1.

Table 2.1 Pumice Chemical Analysis

Chemical Composition	**Rate (%)**	**Chemical Composition**	**Rate (%)**
$Si0_2$	*69,78*	Na_2O	*4,33*
AI_20_3	*11,16*	K_2O	*2,87*
Fe_20_3	*2,11*	Cl	*0,0496*
CaO	*2,47*	Total	*98,04*
MgO	*0,60*	Density (g/cm³)	*2,35*
SO_3	*0,06*	Specific Surface (cm²/g)	*6010*
Loss on Ignition	*4,66*	45 micron sieve residue (%)	*10,20*

2.1. Method

Turkish standards for pumice TS 1114 specifies the tests should be applied to lightweight aggregate. Measurements were taken for three different sizes and the arithmetic average of results were determined. Pumice can be used as pure it is also can be used with bonding additives. When mixing the pumice with water, cement or different additives and intended to make a lightweight concrete its density shouldn't exceed 1200 kg/m³. In this research pumice samples selected by adhering this rules. So the selected pumice provides the physical and chemical features**.**

2.1.1 Producing the Samples and Measuring Thermal Conductivity

When the samples produced they have made manually according to TS 2848, TS 3234, and TS 4916.Before mixing the aggregate every bonding elements mixed dry. Lightweight aggregate mixed with cement without adding water. In the mortars cement and lime used together, before lightweight aggregate is mixed with lime. It is same in the plaster. Prepared samples will cast conveniently. Mixture of water / material ratio are identified in Table 2.1[6].

Determining the thermal conductivity of the insulating element the transient method was used. The advantage of this method prevents without causing a change in the material's moisture content during measurement [1, 7, 8, 9, 10, 11, 12, 13, 14].

Table 2.2. Sample Mixing Ratio (as Weight (%))

Sample No	Aggregate (Class (mm))			Cement	Lime	Plaster	Water / Total Dry Mixture
	0/2	2/4	4/8				
1	100	-	-	10	-	-	0.65
2	100	-	-	20	-	-	0.60
3	100	-	-	5	5	-	0.65
4	100	-	-	10	10	-	0.60
5	100	-	-	-	-	20	0.60
6	50	50	-	10	-	-	0.60
7	50	50	-	20	-	-	0.55
8	50	50	-	5	5	-	0.60
9	50	50	-	10	10	-	0.55
10	50	50	-	-	-	20	0.60
11	50	50	-	-	-	30	0.55
12	35	35	30	20	-	-	0.55
13	35	35	30	10	10	-	0.55
14	35	35	30	-	-	20	0.55
15	35	35	30	-	-	30	0.50

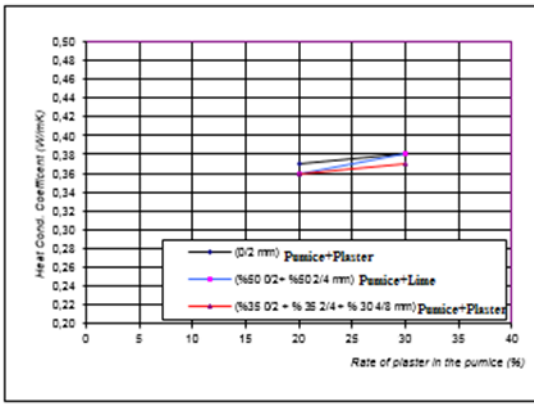

Figure 2.6. Change of Heat Conductivity with Cement-Lime Mixture

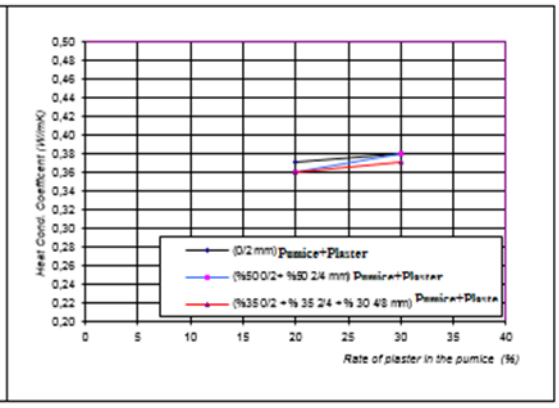

Figure 2.7. Change of Heat Conductivity with Plaster rate

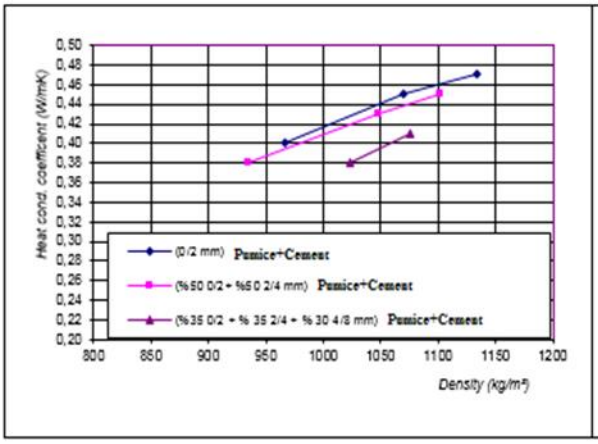

Figure 2.2. Change of Heat Conductivity with Cement Bonding Mixture

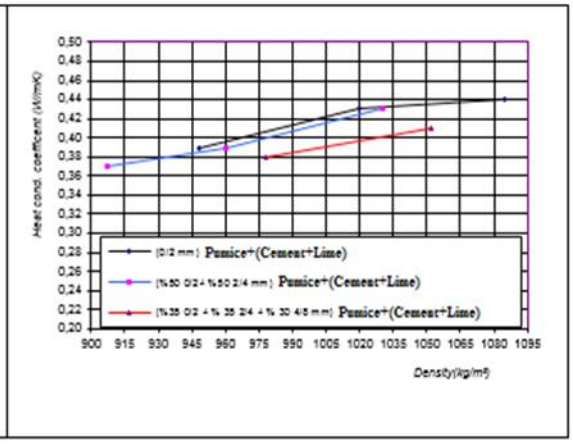

Figure 2.3. Change of Heat Conductivity with Lime-Plaster Bonding Mixture

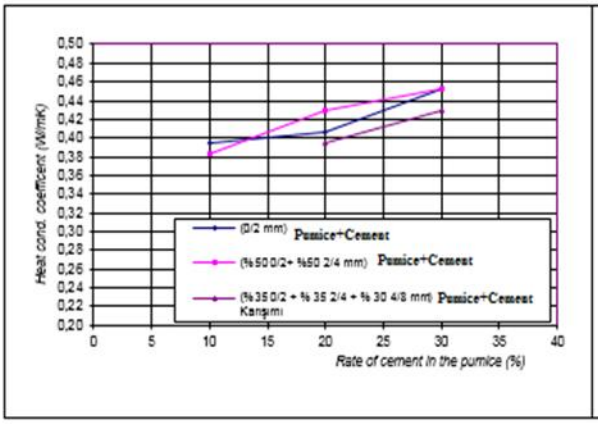

Figure 2.4. Change of Heat Conductivity with Plaster Bonding Mixture

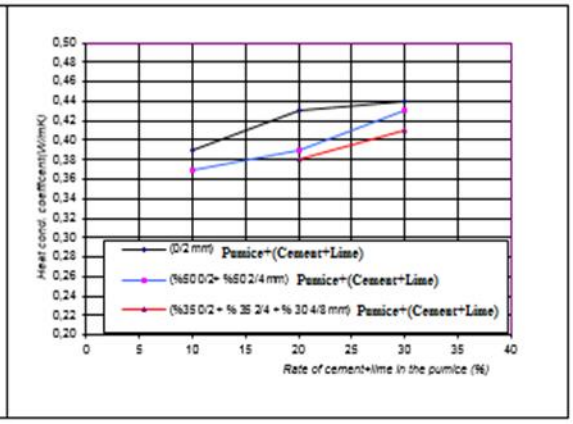

Figure 2.5. Change of Heat Conductivity with Cement Ratio- Heat Conductivity

3. Conclusions and Recommendations

1. When construction materials unit weight increases the thermal conductivity also increases.
2. As the amount of binding of participating in the building materials increases thermal conductivity also increases, compressive strength increases.
3. As the additive material increases, water absorption values decreases.
4. When the gypsum participating 20% placed in water it is dispersed. Therefore, this ratio should not be building material. Water absorption rate of the gypsum material is high.
5. When adding the cement instead of lime + cement, heat transfer coefficient falling around 2.5-10%, by the time it decreases the strength values.

According to the experimental researches, pumice provides energy saving highly and it should be used for insulation material. Thus environmental pollution, labor and shipping expenditures will be dropped.

REFERENCES

[1] ÜNAL, O., ERGÜN, A., UYGUNOĞLU, T., KÜRKLÜ, G., "Hafif Agregalı Elemanların FizikoMekanik Özelliklerinin Araştırılması ve Modellenmesi", Proje No: 109M391, Ocak 2008, TÜBİTAK projesi, 2008.

[2] Güngör, N. ve Tombul, M., 1997, Pomzanın kullanım alanı ile ilgili özellikleri ve mevzuatın pomza madenciliğine etkileri. 1. Isparta Pomza Sempozyumu Bildiriler Kitabı, Isparta.

[3] A. Aslan, B. Yüksel, and T. Akyol, "Energy analysis of different types of buildings in Gonen geothermal district heating system," Applied Thermal Engineering, vol. 31, pp. 2726-2734, 2011..

[4] TC Enerji ve Tabii Kaynaklar Bakanlığı internet sitesi. http://www.enerji.gov.tr Bobrowski, J., 1980. Outstanding Applications of Lighweith Concrete and an Appreciation of Likely Future Developments. The International Journal of Lighweith Concrete, 2, 1, p 5-20.

[5] Clarke, J.L.,1987. Shear Strength of Lighweith Aggregate Concrete. Cement and Concrete Assosiation, Concrete, Vol. 4.

[6] Eroğlu, M.N ve Toksoy, M., 1988, Endüstriyel Malzemelerin Isı İletim Katsayıları, Mühendis ve Makina, 379 (29): 12-15.

[7] Göğüş, Y., 1969, Isı iletkenlik ve yayınım katsayılarının kolaylıkla ölçülmesi. Mühendis ve Makina, 12, (143), 399-401.

[8] Güllüce H. , 1997, Pasinler (Demirdöven) Yöresinde Çıkarılan Pomzanın Isı Yalıtımlı Yapı Malzemesi Olarak Kullanımı, Atatürk Üniversitesi Yüksek Lisans Tezi. Erzurum.

[9] Lang, D.L., 1956, a Quick Thermal Conductivity Test on Insulating Materials, ASTM Bull. No. 216; 58-69.

[10] Arkin, H., K.R., Hulmes , M.M., Chen, 1989, A Thecnique for Measuring the Thermal Conductivity and Evaluating the Apparent Conductivity, Concept in Biomaterials, Transactions of the ASME, 111: 276-282.

[11] Pelanne, C.M., 1978, Does the Insulation Have a Thermal Conductivity? Thermal Transmission Measurments of Insulation, ASTM STP 660 R.P. Yye Ed: 60-70.

[12] Richards, J.D., 1988, Transient Method for Measuring Thermal Conductivity, IEEE Electrical Insulation Magazine 4 (1):23-22.

[13] Vysnlauskas,V.V; Zikas, A.A; Zaliauskas, A.B., 1988, Determination of the Thermal Conductivity of Ceramics by the Hot Wire Technique, Heat transfer-Soviet Research, 20 (1): 137-142.

[14] TS 1114 EN 13055-1:2004, Hafif Agregalar-Bölüm 1: Beton, Harç ve Şerbette Kullanım için, s39, TSE, Ankara. TS 825: Haziran 1999, Binalarda ısı yalıtım kuralları, TSE, Ankara. TS EN 1745:Nisan 2004, Kagir ve Kagir Mamulleri-Tasarım Isıl Değerleri Tayini Metotları, TSE, Ankara. TS EN 998-2:Nisan 2003, Kagir Harcı-Özellikler-Bölüm 2: Kagir Harcı, TSE, Ankara. TS EN 771-3:Nisan 2005, Kagir Birimler-Özellikler-Bölüm 3:Beton Kagir Birimler (Yoğun ve Hafif Agregalı),TSE, Ankara. TS 3234, 1978. Bimsbeton Yapım Kuralları, Karışım Hesabı ve Deney Metotları, 30s. TS 3673, 1982. Beton Agregalarında Organik Kökenli Madde Tayini Deney Metodu, 4s. TS 2823, 1986. Bimsbetondan Mamul Yapı Elemanları (Tadil: 1988/08), 27s.