Performance powered by nature.

Fact Sheet

Paper and plastic sacks provide equivalent shelf life

Research objectives

The European Paper Sack Research Group (ESG) commissioned the Norwegian research organisation SINTEF to investigate the shelf life of the packaging solutions used most widely throughout Europe for the packaging of cement: paper sacks and polyethylene form-fill-seal (FFS) sacks. Stakeholders have claimed that plastic bags provide a better shelf life than paper bags. Although the typical storage time for bagged cement in Europe is estimated to be no longer than 2 to 3 months, the study set out to determine how the sacks perform throughout longer storage periods of up to 18 months.

Materials

For the investigation, a standard 25 kg European cement paper valve sack made of two paper layers of 80 g and 70 g with a 12 µm high density polyethylene (HDPE) free film barrier and a standard plastic sack made of three layers of COEX PE film (LDPE, HDPE and LLDPE) with a total thickness of 120 µm were used. All sacks were filled with Portland cement CEM I 52.5 R according to European standard EN 197-1 cement. Due to their smaller capacity, two plastic sacks were employed for each batch of 25 kg cement.

Storage conditions

Stored in an outside storage house in Norway, a total of three sacks per type were tested. Representing the typical secondary packaging, the sacks were stored on a wooden pallet covered by a plastic stretch film. The sacks were exposed to changing climatic conditions. Temperatures varied between –17.9 °C and 32.1 °C and the relative moisture ranged from 28% to 96% (sampling of humidity on a random basis).

Sampling and homogenisation

After 9, 12 and more than 18 months of storage, cement samples from both sack types were collected and analysed. The sampling and homogenisation of the cement was conducted as follows: In the first step, the cement was divided into four equal parts. Secondly, two diagonally opposed quarters were recombined and manually homogenised (mixed). Step 1 and 2 were repeated three times, resulting in sampling approximately 3 kg of cement from each sack which was sent for analysis.

Test methods to evaluate cement properties

The samples were subjected to three different test methods to determine the water content in the cement and the performance of the cement after each storage period.

1) Thermogravimetric analysis

In a thermogravimetric analysis, the total amount of physically and chemically bound water in the cement was measured by registering the weight of the sample as it was heated from 30 °C to 950 °C. A weight loss (loss on ignition) would indicate the formation of a hydrate product due to the release of H_2O (decomposition of hydrates) or CO_2 (decomposition of carbonates).

2) Calorimetric analysis

Secondly, a calorimetric analysis was conducted on the cement paste mixed externally from the samples to measure the amount and rate of heat which evolved during cement hydration. Measurements were performed up to 24 hours from the point of first contact between dry powder and water against a calibrated reference of similar mass and heat capacity. As the hydration reactions proceed, heat is released. The heat production rate, which is proportional to the hydration rate of the cement, is recorded in the isothermal calorimeter.

3) Mortar casting

The third analysis was mortar testing, which measured the initial flow and 28-day compressive strength according to DIN EN 196. This test method indicates if the performance of cement varies or remains constant over the defined period.

Results

1) Thermogravimetric analysis

According to the thermogravimetric analysis, with increasing storage time the total weight loss for paper sacks increased slightly more than for plastic sacks. It was 3.17% for plastic sacks and 3.61% for paper sacks. However, this latter result is an increase of only 0.55 percentage points compared to the fresh cement and is still within the requirement of ≤ 5.0% loss on ignition for cements according to DIN EN 197-1.

2) Calorimetric analysis

The calorimetric tests showed that the levels of hydration within 24 hours were essentially unchanged. The cumulative heat of hydration after 24 hours, which correlates to the mortar strength at 24h, was within the standard repeatability (5–7 J/g) for all the tested cement samples.

3) Mortar casting

The mortar strength at 24h was also within the standard repeatability for all the tested cement samples. The flow and the 28-day compressive strength for mortar cast with the cements did not change significantly after storage in both tested sacks.

Summary

The outcome of the tests revealed that the quality and performance of the periodically sampled cement from both types of sacks was well within the requirements of the cement industry concerning the properties of the product. The study showed that paper sacks provided an equivalent shelf life of at least 18 months for cement as form-fill-seal (FFS) polyethylene sacks.

Strong environmental credentials

At the same time, the carbon footprint of paper sacks is 2.5 times smaller than that of plastic sacks. This is the result of another recent study by the Swedish research institute RISE. Read more details here.

SINTEF *is one of Europe's largest independent research organisations with international top-level expertise in the fields of technology, the natural sciences, medicine and the social sciences.* ***www.sintef.no/en***

CEPI EUROKRAFT
European Producers of Sack Kraft Paper and Kraft Paper

CEPI Eurokraft *is the European Association for Producers of Sack Kraft Paper for the Paper Sack Industry and Kraft Paper for the Packaging Industry. It has eleven member companies representing a volume of 3.0 million tonnes of paper produced in twelve countries.* ***www.cepi-eurokraft.org***

eurosac

EUROSAC *is the European Federation of Multiwall Paper Sack Manufacturers. The federation represents over 75% of European paper sack manufacturers. Its members operate in 20 different countries. They produce more than 7 billion paper sacks per year, representing 900,000 tonnes of paper converted in 60 plants. Sack manufacturers from all continents and bag manufacturers also contribute to the federation as corresponding members, and more than 20 suppliers (paper, film, machine or glue manufacturers) are registered as associate members.* ***www.eurosac.org***