Firmocret Feasibility Report

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Main Components:

Concrete Component/Portland Cement:

-Production is long, arduous, and costly

-Carbon dioxide is released during production

- Highly toxic when wet

Concrete Component/Sand:

-Main material of concrete.

-Costly to use

-Pushes contractors to use non-durable alternatives such as sea sand.

Firmocret Component/Waste Plastic/Glass/Recycled Concrete:

-Substitutes for Sand/PC

-Cheap to acquire

-Obtained via recycling

-Supports Zero-Waste movement

-All three are durable as the main components

Firmocret Component/Fly Ash:

-Also known as PFA

-A byproduct of coal-based energy production

-Can be recycled and used

-Contributes to the environment by using the byproduct of a process that releases carbon dioxide.

Concrete Component/Synthetic Polymers:

-Petroleum-based

-Nylon, polyester, and Teflon are examples

-Environmentally harmful, toxic, cannot be mixed into the soil, and costly

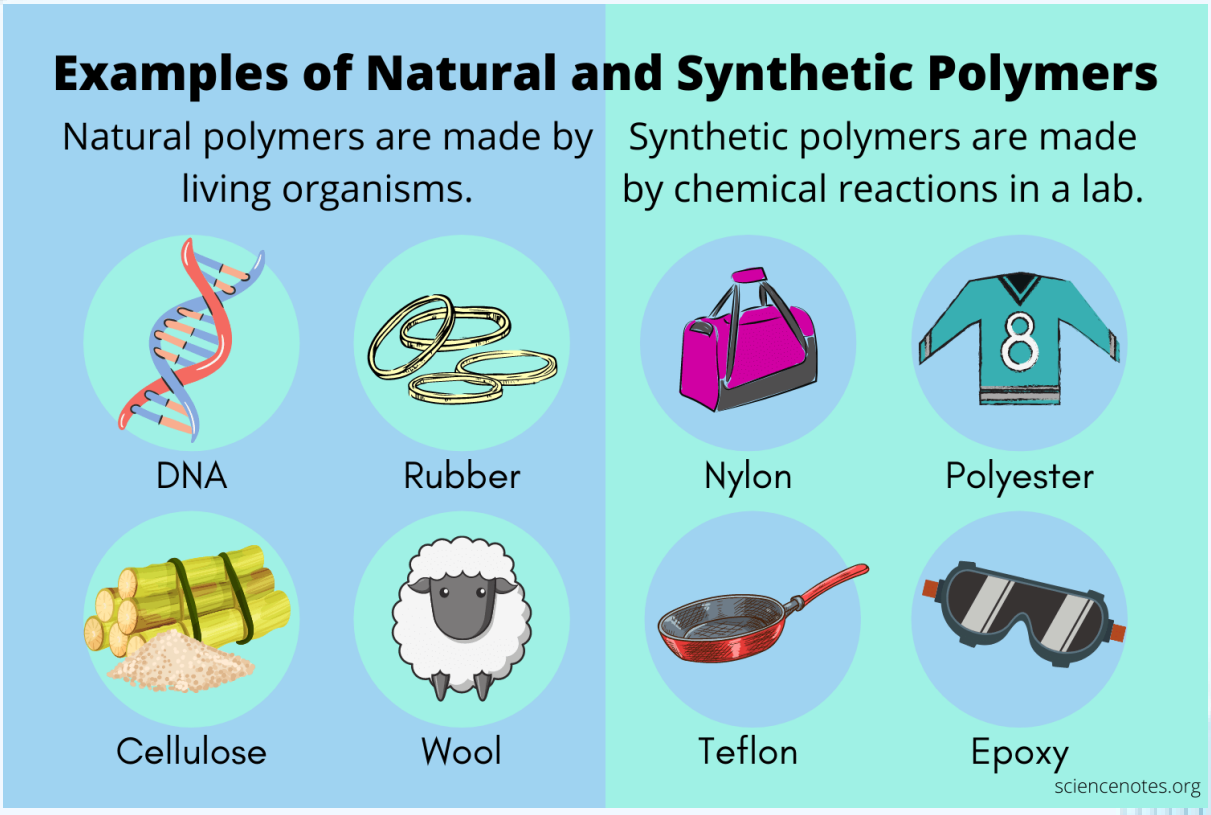
Firmocret Component/Plant Fibers (Cellulose):

-Cheap to produce

-Obtained from plant-based substances with the help of the Kraft Method

-Watermelon rind/wheat stalks

-Durability is almost the same as synthetic polymers.



Concrete Component/Water:

-Used in the production of normal concrete

-Must be used in high amounts

i. Increases water scarcity.

Firmocret Component/Plasticizer:

-Easy to acquire

-Cheap and effective.

i. Plasticizers added instead of water are obtained from natural sources. “Sunflower Oil” and “Soybean Oil” can be given as examples of plasticizers.

Production Phase

1- Kraft Process:

-Kraft Process or Kraft Pulping is the most common form of chemical pumping. It serves as the main process for Cellulose extraction. The process comprises about 80% of the entire pulping industry. First digested in high temperatures and then compressed in white liquor, lignin* in the wood chips is dissolved. Said pulping process is conducted in Digester Systems*.

i. Lignin* is the main substance that keeps the cellulose molecules together.

ii. The Digester System manages the physical pumping process. Two types of the said systems are “Batch” and “Continuous” systems.

- Batch systems form the majority of Digester Systems. First cooking the wood chips and sending them to a blow tank*, Batch systems separate the black liquor* from the fiber in pulp washers. Said washers conduct this by using water.

  i. Blow tank* is an atmospheric tank responsible for mixing the pulp with black liquor to acquire perfect material consistency.

  ii. Black Liquor* is a byproduct of the Kraft Process. It consists of sodium hydroxide, sodium carbonate, sodium sulfide, sodium sulfate, several other sodium salts, and organic matter. Said substance is 70% organic and 30% inorganic. In addition, diluting black liquor with water serves as a good substitute for excess water usage in the Kraft Process, as proven by research from 2018 conducted in the National Renewable Energy Laboratory and Thermo Fisher Scientific.

- Continuous Digester Systems have the same process, with the major difference being the lack of loading material interruption and unloading effluent.

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2. Waste Incorporation Process

The next process is about mixing the aforementioned waste products with Portland Cement. Different amounts of both substances were experimented with recently, with the result of research suggesting that the best amounts for both materials are 40% Portland Cement and 60% Polythene type plastic.

i. Not all types of waste plastic are feasible to use. The preferable type of plastic for Firmocret is Polymethyl Methacrylate since it has a tensility rate of 48.3 - 72.4.

Material	Specific Gravity	Tensile Modulus (GPa)	Tensile Strength (MPa)	Yield Strength(MPa)	Elongation at Break (%)
Polyethylene (low density)	0.92 - 0.93	0.17 - 0.28	8.3 - 31.4	9.0 - 14.5	100 - 650
Polyethylene (high density)	0.95 - 0.97	1.06 - 1.09	22.1 - 31.0	26.2 - 33.1	10 - 1200
Polyvinyl chloride	1.20 - 1.58	2.40 - 4.10	40.7 - 51.7	40.7 - 44.8	40 - 80
Polytetrafluoroethylene	2.14 - 2.20	0.40 - 0.55	20.7 - 34.5	–	200 - 400
Polypropylene	0.90 - 0.91	1.14 - 1.55	31.0 - 41.4	31.0 - 37.2	100 - 600
Polystyrene	1.04 - 1.05	2.28 - 3.28	35.9 - 51.7	–	1.2 - 2.5
Polymethyl methacrylate	1.17 - 1.20	2.24 - 3.24	48.3 - 72.4	53.8 - 73.1	2.0 - 5.5

ii. This also is the step where Fly Ash is utilized. By mixing the Portland Cement with Fly Ash, tensility can be increased and the amount of Portland Cement can be reduced. Using Fly Ash is proven to require less electricity in this process, as the energy requirement is as low as 15% of that of traditional concrete.

3. Plasticizer Manufacturing

-Currently, the main trend for plasticizer manufacturing is simply forcing alcohol and a specific type of acid, such as adipic acid, to react. Firmocret leaves this trend alone though, since the outcome of this reaction tends to be a toxic material.

-Firmocret utilizes biopolymers such as epoxidized triglyceride vegetable oils from soybean oil, linseed oil, castor oil, sunflower oil, and fatty acid esters. Said are manufactured from plants, thereby getting rid of the toxicity issue.

-Ways of Plasticizer Manufacturing are namely “Volatile Solvent Extraction” and “Mechanical Pressing*.”

i. Volatile Solvent Extraction is the chemical way of extracting vegetable oils. In this process, a solvent is used to extract the oil out of the plant.

ii. Mechanical Pressing is simply using an oil mill to obtain the oil from the plant. It is the physical alternative to Volatile Solvent Extraction.

4. The Mixing Process

-Unlike the aforementioned Kraft Process, the Mixing Process serves as the main way of making the concrete itself. After acquiring all of the aforementioned core materials and putting them into the mixing machine, the conductor mixes the batch with raw concrete. This way, Firmocret is acquired.

Advantages:

- **Lower Cost:** The aforementioned processes utilize all the research for cost reduction and efficiently recycle the material; thereby, sustaining lower costs.
- **Innovative:** Using creative techniques such as the utilization of Kraft Pulping and natural materials such as “Cellulose” and “Sunflower Oil,” Firmocret has more going on in its innovation stage.
- **No Durability Loss:** Despite using cheap and natural alternatives, Firmocret does not lack in terms of durability. This factor combined with the lower costs pushes the buyers forward to purchase Firmocret instead of cheaper and weaker solutions.
- **Fast Implementation:** Using Turkey’s resources instead of imported ones, Firmocret reduces the governmental deficit in the construction industry, contributing to the national income.
- **Quick Restoration:** Firmocret serves as a better substitute to replace buildings damaged by earthquakes due to a lack of import need. Since Turkey is in an active earthquake zone, this proves to be pretty effective.
- **Waste Utilization:** Firmocret utilizes agricultural and industrial waste in production phases. Since Turkey depends on the said two economic areas, Firmocret provides further productivity.

Goal/Composition Summary:

Widely used today, concrete is obtained from synthetic polymers and sand. The durability and usefulness of this concrete is low, but its price is high. Contractors who were

aggrieved by high prices found the solution by using sea sand, which may contain seashells, instead of quality sand. Firmocret provides a solution to this problem and develops a new concrete that has a low cost and high durability with Turkey's resources.

Acquired from plant-based and cheap structures such as wheat stalk/watermelon rind, Cellulose serves as an alternative to synthetic polymers. In addition, Firmocret replaces the sand used in concrete making with sorted rubbish and similar plant-based structures. This way, cheaper and more durable concrete is obtained.

In conclusion, Firmocret consists of different materials with unique properties, making it a creative and cheap substitute for the current concrete.

Additional Information:

1-Sand and Portland Cement are substitutes for each other. Similarly, waste materials and Fly Ash also serve as substitutes.

2-Portland Cement is not fully substituted. It still must be used for a proper texture. Still, Firmocret uses 60% less Portland Cement than the popularized and currently marketed plastic.

References

(Will be added soon)