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# Stone paper, an eco-friendly and free-tree papers **FREE**

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# Stone Paper, an Eco-Friendly and Free-Tree Papers

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**Abstract** An innovation in paper technology that is totally different from the papermaking technology that has been known now, has been found in the 21st century in China. This new discovery paper does not use cellulose fibers as its raw material, and does not use water at all in its production process. Because it is made of inorganic mineral coming from calcite rocks, this paper is called 'rock paper' or stone paper. The process of stone papermaking in principle mixes fine powder of calcite rock with non-toxic resin, one of which is HDPE (high density polyethylene), as well as other additives, then melted at high temperatures and formed into a sheets like paper. The properties of stone paper are very similar and even have advantages compared to conventional paper. This type of paper is claimed to be more environmentally friendly than conventional paper because it does not use plant fibers as raw material, which means there is no trees cut. It can be recycled and produces low greenhouse gas emissions.

## INTRODUCTION

The term "paper" that we know so far, most of its components is cellulose fibers, either in the form of virgin fibers obtained from wood or non-wood plants, or secondary fibers from the recycled waste papers. This conventional paper production process is closely related with environmental issues, starting from the acquisition of raw materials up to the papermaking processes, even after the production process. The use of wood raw materials is related to deforestation which causes Green House Gasses (CO<sub>2</sub>) emissions. Pulping processes, especially those carried out chemically, also have the potential for environmental pollution coming from waste water, solid wastes and even gas emissions to the air. Similarly, the pulp bleaching process involves hazardous chlorine-based chemicals. In addition to the pulping process, the papermaking process also involves the use of huge amount of resources, such as water and energy, so that the saving efforts require non-simple technology.

Due to these conditions, in the late of 1990s, a company in Taiwan, Lung Meng Technology Co., began to develop new papermaking technologies called "rock paper" (stone paper). At present, more than 40 countries have patents on this type of paper and their products have been marketed under various trade names, including Modestone, GPA UltraGreen, MIST Paper, Parax Paper, Terraskin, ViaStone, Kampier, CleanSlate, EmanaGreen and Rockstock, Pixz Printing, KYStone Paper and Nu Stone, Rock Paper, Paper from Waste Marble, Mineral Paper, Rich Mineral Paper, Sustainable Paper, or Eco Paper [2].

The term "stone paper" is not very appropriate because there are fundamental differences in the type of this product compared to paper products that have been known so far. But, because of its similarity with the conventional papers, especially related with the form, characteristics and the use of this product, the authors try to use the term of "stone paper" for this type of product, which means a paper made from stone.

In the conventional papermaking process, the raw material used consists of cellulose fibers, chemical additives, and large amounts of water. Sheet formation of paper is carried out on a paper machine whose working principle is the process of removing water from the paper stock. It is starting with the drainage and vacuum of water in the wire section. After passing through wire part of paper machine, about 80-75% of water still remain in the wet sheet before it is transferred to the press part. Herein, more water will be pressed out from the wet sheet resulting more

compact and stronger sheet. Finally, with the moisture content of about 20-25%, the water in wet sheet is evaporated using a sets of dryer cylinders heated by steam.

The process technology of stone paper is totally different compared to conventional papermaking process, both in terms of raw materials used and in the process technology. To provide an overview of this new type of paper, this article contains about description of raw materials, process technology, characteristics, along with various environmental aspects of stone paper.

## WHAT IS STONE PAPER?

Paper production technology was first discovered in China around two thousand years ago. In the 21<sup>st</sup> century, China again made a breakthrough by creating a new type of paper that is waterproof or even water-repellent, and does not use plant fibers as raw material, or even water in its production process. This redesign of paper is accompanied by technological innovation in the production process which is completely different from the paper making process known so far [1, 5].

"Stone paper" is also known as rock paper, paper from waste marble, mineral paper, or rich mineral paper. Stone paper is a product resembling paper. It is strong and durable; made from calcium carbonate with a binder of high density polyethylene (HDPE) [2].

Stone paper is a term that describes a number of formulas for papermaking which basically contain calcium carbonate which can come from waste rock, marble and tiles, not from plant fibers [3]. The main content of rock paper is calcium carbonate which comes from stone (rock); so that stone paper is sometimes also called rock paper. Stone paper is made from stone which is crushed into powder form, mixed with a non-toxic and recyclable binder, i.e. HDPE [7].

Stone paper containing 80% limestone and 20% recycled polyethylene have been produced by a printing industry in Germany. The mixture of raw materials used are claimed environmentally friendly and can be used for several printed products such as posters, leaflets, up to bag products, and used by farmers for labels and coatings of pot. This paper can be used as a substitute for polypropylene because it is more water resistant, ultra violet (UV) resistant, with high tear strength, even higher than ordinary paper. In addition, stone paper can be even written when it is in wet condition [9].

Rock paper is claimed to be very environmentally friendly paper. It is different from conventional paper because it does not use wood pulp as its raw material. The technology for making stone paper is also claimed not to pollute air and water; no chlorine or acid compounds used, and the resulting stone paper is really non-toxic and even food safe [7]. It is also believed that the stone paper production process improves air, soil and water quality, and reduces energy consumption [12].

The basic difference between stone paper and conventional paper is in terms of the raw materials used. Conventional paper uses plant fibers as raw material and a lot of water in the production process, while stone paper does not use plant fibers and water at all in its production process. In addition, stone paper production produces low carbon emissions, no acid, base nor bleaching chemicals require, and stone paper can be recycled [3].

It was reported that in the first phase of stone paper production in a factory in Jiu Hua Mountain, China, the raw material used was calcite stone which was crushed into particle form and mixed with 10 other materials [4]. Another interesting thing from the technology of stone paper making process is that the investment costs of production equipment are 40% lower than conventional paper mills for the same production capacity, for example 120,000 tons per year. This is due to no water used in the production process. In other words, the factory does not need to install a water treatment unit, so that it can reduce investment and energy costs. In addition, the cost of pulp is replaced by crushed stones at a much lower cost, which is only \$ 200 per ton. Although the price of virgin polyethylene as a binder is quite expensive (\$ 1,500 per ton), but due to its use in only a small amount (20-40%), the overall cost of raw materials (weight basis), stone paper is lower up to 40% compared to conventional paper [1].

## STONE PAPER MANUFACTURING

Stone paper is made from the mixture of powdered inorganic minerals, HDPE (high density poly-ethylene) plastic and additives. Inorganic minerals is a material utilized as same as like fibers that used in conventional papers. Meanwhile, HDPE polymer is used as an inorganic minerals' binder, so that a mixture can be formed into single sheet or composite.

At the beginning of its development, the inorganic minerals used came from calcite rocks [4]. Calcite is a carbonate mineral and the most stable polymorph of calcium carbonate ( $\text{CaCO}_3$ ) [12]. According to its name, stone paper is made primarily of calcium carbonate, one of the most common inorganic minerals in conventional papermaking process which has been used extensively as filler and coating pigment. In making stone paper, the mineral is being the heart of the product, comprising 80% of its composition [3]. Stone paper can be made also from the building industry waste. Offcuts and waste stone rock, marble and tiles are ground to recover calcium carbonate ( $\text{CaCO}_3$ ). Stone paper made from 80.9% of this material has been produced and marketed commercially [10].

HDPE is used as a binder to keep the calcium carbonate still retain in a flat sheets, and to give the foldable quality of stone paper similar to conventional paper [3]. In further developments, various efforts were made in order to replace or substitute HDPE by other materials that have similar characteristics to HDPE.

The stages of stone paper making process can be seen in Figure 1. In grinding process, after cleaning and breaking, the rock/stone blocks are crushed into 600 mesh's powder with the average diameter of 5-8  $\mu\text{m}$  [13]. To avoid the generation of dust, the crushing machine equipped with a pipeline for transferring the primary material to the subsequent process area, i.e. pellet production unit. [1].

A wide variety of mineral sources which is calcium carbonate-rich can be utilized as an input material as long as it meets the standard size of fine dust [1]. In further developments, various types of inorganic minerals can be used as raw material for stone paper, such as  $\text{MgCO}_3$ , calcium silicate or its mixtures [12].

After being surface-active treated, the mineral powder is mixed with polyethylene resin, and formed into granule particles at high temperatures and high pressures. At this stage, the catalyst can be added to increase the dispersion ability of the mixture. Furthermore, rock paper is made using the blown-film method under controlled conditions of air pressure, air volume, traction speed, discharge speed and other parameters automatically using the Programmable Logic Controller to precisely control the thickness and uniformity of paper sheets [13].

The coating process is aimed to improve the printing ability of stone paper. It includes leveling, corona, coating, drying, calendaring and other processes of sheets at the high-speed double-sided coating machine [13].

Similar to conventional papermaking process, slitting and cutting processes are the finishing process to convert the stone paper web into final product in the form of sheets or roll of ordered size.

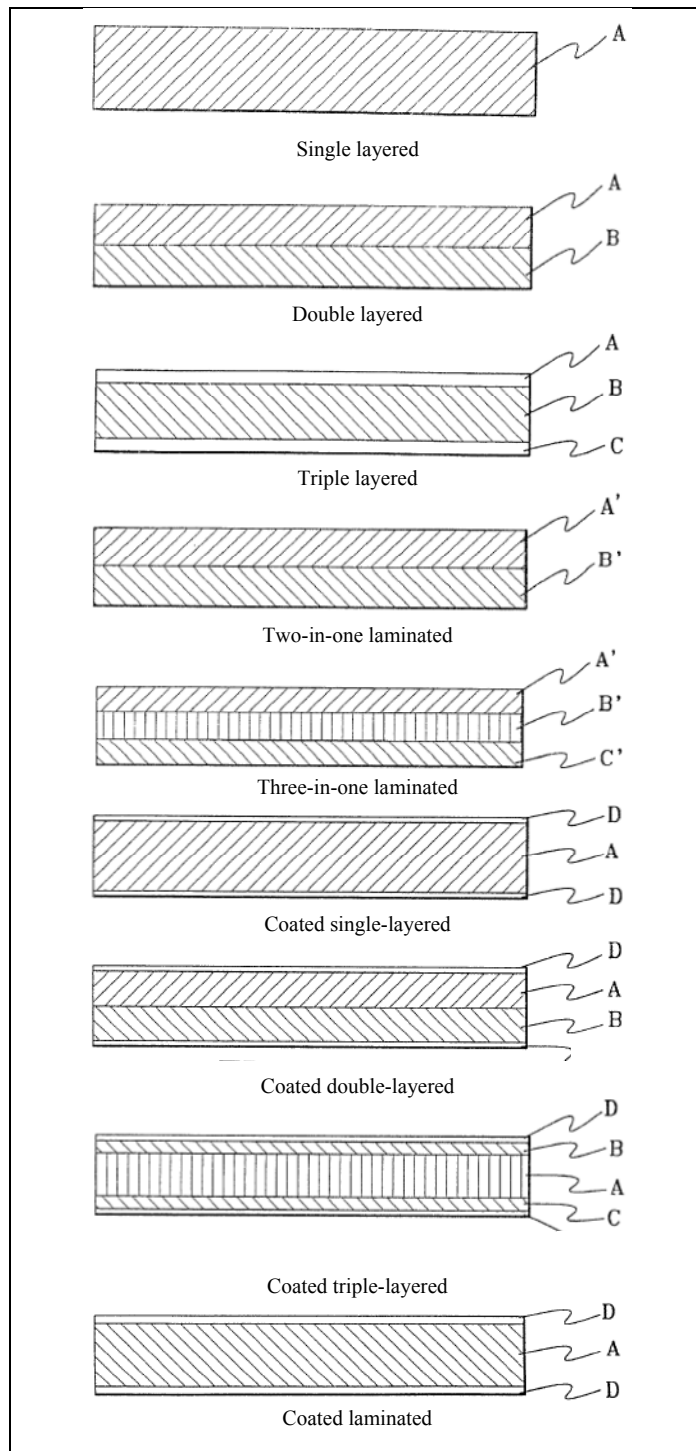
Since it was first discovered in the 1990s, the technology of stone paper making has continued to develop both in terms of raw materials and process technology. In term of process technology, the stone paper can be produced as single or multiple layers using a forming mold having a direct line gate. Other stone paper making technology is by making composites consisting of at least two layers [14]. Figure 2 shows the schematic views of various layer combination of stone paper.

As shown in Figure 1, the structure of layers combination varies greatly depending on the characteristics of the stone paper to be produced. The single-layered composition is the simplest structure which generally consists of inorganic mineral powders as main component, the synthetic polymer as a binder, and a small amount of additives such as coupling agents, lubricants, dispersing agents, and antistatic agents [14].

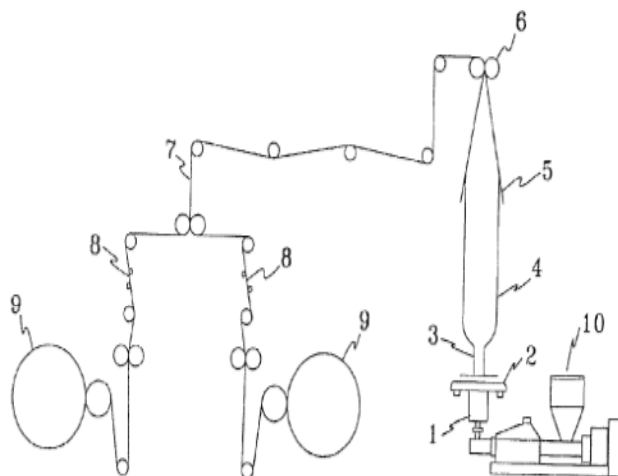
The double-layered and triple-layered stone papers are almost similar to single-layered composition. The difference is related to the forming mold design. The inlet of forming mold for double-layered and triple-layered is replaced by two and three inner passages respectively [14]. Of course, the composition of the material in each layer can be varied according to the needs.

Another method for combining the layers is by the lamination of two or three different layers in order to gain as much as possible the advantages of each layer. All of these kind compositions can be two-side coated to improve their printing ability.

The technology of stone paper sheet forming is depended upon the layer composition of stone paper to be made. The technology for single-layered stone paper manufacturing process is shown in Figure 2 [14].



**FIGURE 1.** Layer schematic picture of stone paper [14]



**FIGURE 2.** Flow chart of single-layered stone paper manufacturing process [14]

After being processed in a series of mixing steps, all materials of stone paper in the form of granules are fed into an extruder (10) to be melted before being formed into sheets. The temperature of extruder is set above melting point of granules, in the range of 150°C up to 220°C. The melted granules are forced by two rotating screws in the extruder to the inlet of forming mold (1) having an o-shape gate, and then molded to a paper film through a paper film tube (3) having also a hollow o-shape. The paper film tube (3) has temperature as high as 150-220°C, so it is cooled down by cooling wind provided by cooling means (2) to about 80°C up to 120°C. The paper film tube (3) is then inflated by pressured air through a passage in the forming mold (1) and the initially molded paper film tube is drawn by leading roll (6). The purpose of inflation and drawing is to simultaneously stretch the paper film (3) in two directions, latitudinally and longitudinally, resulting in a paper (4) having a structure with two dimensional strength. After that, the paper film is drawn into folding means (5) and folded symmetrically to folded flat paper and then cut using cutting means (7) into two sheets of paper. The two resulting sheets of paper are each subjected to double-sided surface treatment (8) to provide micro voids on the two surfaces of paper, and then wound into a roll (9).

The rotation speed of leading roll (6), the amount of material extruded (10), and the required thickness of paper film tube are precisely controlled so that the paper film tube (3) can be inflated three to eight times at a distance of about 200 mm to about 700 mm from the forming mold gate (1). During inflation, the density of paper film (4) is reduced from 2 g/cm<sup>3</sup> of the raw materials to about 0.5 g/cm<sup>3</sup>. This saves the amount of volume by about 40% compared to the pulp density of about 0.7-0.9 g/cm<sup>3</sup>. The range of thickness, width, and density of stone paper produced can be arranged about 30-150 μm, 0.2-3.2 m, and 0.4-1 g/cm<sup>3</sup> respectively. [14]

### **The Manufacturing Process Need More Explain Their Function in Every Steps**

The technology of lamination and coating of stone paper are almost the same with the technology generally used for paper lamination and coating. The lamination is done in order to obtain the advantageous of each layers, while the coating process generally done to improve the surface quality of paper, for example to improve the printability, surface strength, water resistance, etc.

### **TYPES AND CHARACTERISTICS OF STONE PAPER**

Basically, stone paper is divided into 2 classes, namely S-class and R-class. S-class means Sustainable rich mineral paper range; it's the original stone paper. While, the R-class is Recycled rich mineral stone paper range [5, 7, 10]. Each class consists of a series of product variants whose types depend on the manufacturer. Both S-class and R-class series are divided into Eco-, Board-, Film-, and Thermo-sub classes [5]. Table 1 summarizes some variants of S-class and R-class stone paper.

**TABLE 1.** Several product variants of S-class and R-class [5, 7]

<b>Class</b>	<b>Variant</b>	<b>Description</b>
S-class	SP <sup>[5]</sup>	For plastic film applications 80 –100 microns thick 70% calcium carbonate + 30% PE
	ST <sup>[5]</sup>	For plastic board applications 400-700 microns thick 60% calcium carbonate + 40% PE
	SPN <sup>[7]</sup>	For plastic board applications 60 – 100 microns thick 70% calcium carbonate + 30% PE
R-class	RP <sup>[5]</sup>	For paper applications 100 –200 microns thick 80% calcium carbonate + 20% PE
	RB <sup>[5]</sup>	For plastic/paper board applications 200-400 microns thick 60% calcium carbonate + 40%PE

Other manufacturers named their stone paper product variants as SPN (Synthetic Paper No Coated), RPD (Rich Mineral Paper Double Coated), RBD (Rich Mineral Board Double Coated), and ST with different stands for, i.e. Stone Paper Thermoforming Board. Table 2 below presents the specification of those product variants [7]. The density of stone paper ranges from 1.0 g/cm<sup>3</sup> up to 1.6 g/cm<sup>3</sup>; slightly higher compared to conventional pulp paper, and the appearance looks like the outer membrane of boiled eggs. The surface of stone paper is smoother than traditional paper, and compatible with inkjet printers or solid ink printing such as offset, letterpress, gravure, and flexographic, but not suitable for laser printers [2].

Stone paper has no static charge, with neutral pH, and resistant to water penetration, grease, and insect attack [2]. The edge of stone paper won't cut fingers such as traditional paper. It is tear resistant, and provides durable and long lasting products [5].

Stone paper has unique characteristics such as anti-moth, anti-mildew, tear resistant, photodegradable, recyclable, soft, durable, oil resistant, water-proof, and stable in color [3, 4, 5, 6, 7]. It is also claimed that stone paper can be written while it is wet, and even the note book made from stone paper, it can be used as an umbrella [5, 7].



TABLE 2. Specification of product variants [7]

Variant	Thickness ( $\mu\text{m}$ )	Density ( $\text{g/cm}^3$ )	Basis Weight ( $\text{g/m}^2$ )	Opacity (%)
SPN	60	1	60	> 70
	80		80	> 80
	100		100	> 80
RPD	100	1.2	120	-
	120		144	-
	140		168	-
	160		192	-
	180		216	-
	200		240	-
RBD	200	1.5	300	-
	250		375	-
	300		450	-
	350		525	-
	400		600	-

## ENVIRONMENTAL ASPECTS

### No Trees Cut Down

One metric ton of conventional paper made from wood uses around 4 metric tons of wood chips from around 23 large trees that are cut down [5]. In the last 40 years, worldwide conventional paper consumption has increased by 400%. Fiber used as raw material comes from 35% of wood harvested [10], and it can even reach almost half of it used for pulp and paper raw materials [5]. Even though, there is not much wood for pulp raw material coming from natural forests, only around 10%, but this is the most controversial issues. The source of wood fiber for pulp generally comes from monoculture plantations which also raises concerns about its impact on forest ecology [10]. Deforestation is a problem faced not only by developing countries, but also by developed countries. The use of stone paper as another alternative to conventional paper may contribute in overcoming the problem of deforestation [10]. The main raw material of stone paper is calcium carbonate in the form of calcite, rocks, marble, or others. The amount is about 80% of all materials used. As a binder, synthetic polymers such as HDPE or others are used. In addition, a small amount of additives are added to improve the run ability of stone papermaking. There is absolutely no fiber added to the sheet, which means no trees are cut down as is the case with conventional papermaking processes [3, 5].

### No Water Pollution and Air Pollution

In conventional papermaking process, a large amount of water is used as a medium for mixing the fiber and additives used, for the transfer of solid materials from one stage of process to subsequent process stage, and for other purposes such as cleaning the production area.

In conventional paper machine, when the paper stock is spread over the wire, water is gradually removed from the sheet starting from drainage gravitationally and vacuum on the wire, then more water is squeezed in the pressing process, and finally the rest is evaporated on the drying cylinders. A lot of water used in the production process means a lot of wastewater will be generated as well, and it increases the load of wastewater treatment plant. To avoid the environmental pollution is one consideration in stone paper innovation at the beginning stage of its development. As illustrated in Figure 3, stone paper making does not require water in all stages of the process, however if there is use of water, the amount is not significant [3, 5].

Replacing 1 ton of conventional paper with 1 ton of stone paper will save 7,480 gallons of fresh water [4, 5, 7, 10]. In stone paper production, water is only needed for circulating cooling water [7].



The stone paper production process has designed to prevent emitting toxic gasses. And it is also claimed that stone paper production generates low carbon emission [3, 5, 10].

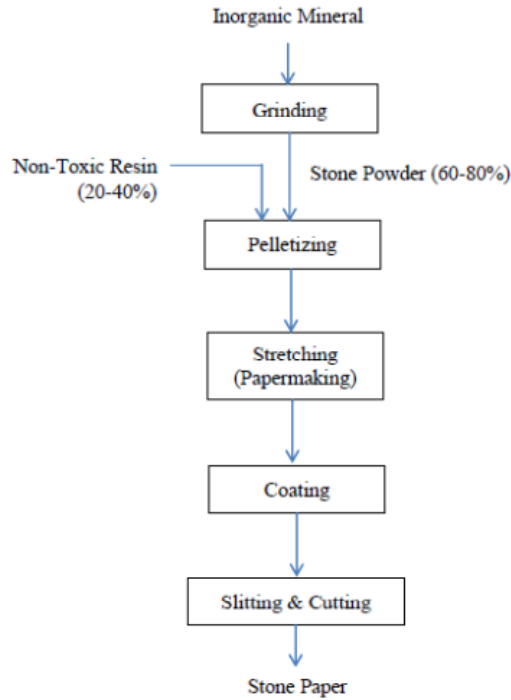


FIGURE 3. Stone-paper production process [5]

### Photodegradable

Unlike the conventional paper made from fiber which is biodegradable, the stone paper is not biodegradable [3], but it is photodegradable and can be decomposed after being exposed to sunlight for a certain period of time. The time required varies from 12 months to 18 months depending on the type of products [3, 5, 8, 20, 25]. An experiments on 200µm thick samples showed that the photo degradation and cracking were occurred after 6 months exposure to direct sunlight [3]. However, what happens to HDPE components after the process occurs can't be clearly explained. Thus stone paper will not be degraded at all if buried in the soil or stored in a place that is not exposed to direct sunlight [3, 25].

This becomes interesting if stone paper is used for outdoor purposes. Stone paper makers are required to think of a way that the rate of stone paper photo degradation can be controlled according to the requirement. For this purpose, a UV light barrier material can be added to control the rate of photo degradation of stone paper [5].

### Recyclable

Stone paper can be easily recycled back into stone paper or become number 2 plastic [8]. The recycling back into stone paper is categorized as an R-series (Recycled-series). [3, 5, 20, 21]. It is a category of eco-solution products which uses 20-100% recycled stone paper mixed with 80-0% of virgin stone paper [20]. The materials composition of R-series products are listed in Table 3.

**TABLE 3.** Composition of R-Series [21]

	<b>R-Paper (RP)</b>	<b>R-Film (SP)</b>	<b>R-Board (RB)</b>	<b>R-Thermal (ST)</b>	<b>R-Pellet</b>
Recycled	20	30	80	80	100
Virgin	80	70	20	20	0

In developing the stone paper sustainability, the concept of 3-R (Recycling, Reuse, and Reducing) has been implemented. The closed loop recycling system has been designed in stone paper mill in order to minimize the stone paper which is thrown away or burned in the furnace. Reusing of industrial waste or post consumers product for other products was also developed both in stone paper mill and converters. Besides, the efforts to reduce the environmental impacts of stone papers were done by reducing the synthetic binder used as well as increasing the portion of inorganic mineral. The percentage recycling and reuse of stone papers or its components are showed in Table 4.

**TABLE 4.** Recycling and Reuse of Stone Paper and Its Components [20]

<b>Reuse Material &amp; Percentage</b>	<b>Recycle Back to Mill</b>	<b>Recycle via Plastic #2 or #7 Channel</b>	<b>Photo degrade</b>	<b>Furnace</b>
Reuse PE, %	98-100	98-100	0	0
Reuse Stone Powder, %	98-100	98-100	98-100	98-100
Reuse Stone Paper, %	98-100	98-100	60-80	60-80

The recycling of stone paper can be categorized by 3 systems i.e. after they are produced in the manufacturer (post-industrial), after used by the customer (post-consumer), and at the end of stone paper's life [20]. Post-industrial recycling system processes scraps from stone paper factories into R-pellets then mixes with virgin stone paper on the composition according to the type of R-series products to be produced. Then, the resulted PE-resin is ready to be converted into R-series products. At the post-consumer recycling process, recycled stone papers are heated together with other recycled plastic in certain mixture compositions. The PE resin produced is then formed into pellets and then converted into other recycled plastic products. While, at the end of paper stone's life, it is burned in the furnace. The level of combustion temperature in the furnace affects the type of residual ash produced. CaO is formed if the combustion temperature in the furnace is quite high, while at low temperatures the residual ash produced is in the form of CaCO<sub>3</sub>. Both CaO and CaCO<sub>3</sub> can be used as raw materials for other products. CaO is usually used as fertilizer or cement raw materials, while CaCO<sub>3</sub> as construction materials. The burning of stone paper in furnace produces CO<sub>2</sub> emissions that is significantly lower than 100% PP plastic, or synthetic paper, even lower than conventional paper (Figure 4) [20].

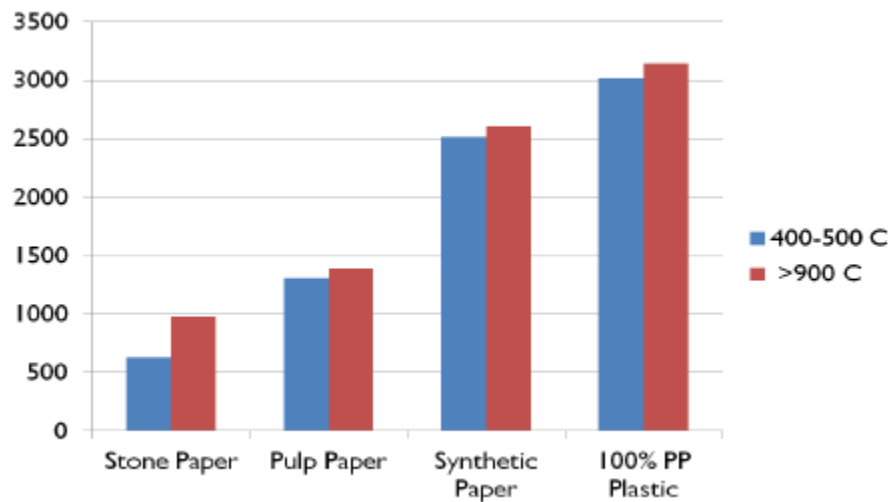


FIGURE 4. CO<sub>2</sub> release during incineration [20]

Table 5 summarizes the difference of resources consumption in the production of virgin pulp, recycled pulp and stone papers. In addition, compared to 1 ton of pulp paper production, 1 ton of stone paper production will save electric energy by 280 Kwh [7] and 6 million BTU's energy [4, 10], and reduces CO<sub>2</sub> released by 900kg [5].

**TABLE 5. Stone paper compared to virgin and recycled pulp [21]**

	<b>1 ton of:</b>		
	<b>100% Virgin Pulp</b>	<b>100% Recycled Pulp</b>	<b>100% Stone Paper</b>
Trees	20	4	Zero
Waste	Zero	2 tons	Zero
Water	16,000 gallons	9,000 gallons	Zero
Bleaching	Yes	Yes	Zero
Stone	20-30%	20-30%	80%
Additives	0%	0%	20%
Energy	36,000 BTU's	22,000 BTU's	18,000 BTU's

## DEVELOPMENT

Since it was first discovered in the 1990s, many efforts have been made on improving and developing the stone paper. This was evidenced by many new patented findings related with stone paper innovations based on results of research conducted. Some of the findings were described below.

Efforts on development of stone paper were generally carried out in terms of the raw materials used, or in the technology of the manufacturing process. The purpose of the developments were basically to reduce production costs, improve the efficiency of resources used, improve physical and mechanical properties of stone paper sheets, and improve the environmental performance of stone paper production process or the stone paper itself.

As explained earlier, the main components of stone paper are inorganic minerals based on CaCO<sub>3</sub>, which is mixed with synthetic resin, namely HDPE, and small amount of auxiliary materials. Other inorganic substances that can be used as a substitute for CaCO<sub>3</sub> including pure-white silica powder, coarse whiting, calcium sulfate, sodium sulfate, barium sulfate montmorillonite, wollastonite, kaolin, mica powder, metal oxides (magnesium oxide, calcium oxide, aluminum oxide, zinc oxide, titanium dioxide, silica, etc.), metal hydroxides (e.g. aluminum hydroxide, magnesium hydroxide, etc.), a mixture of silicon whiskers, dolomite powder, calcium citrate, glass fiber, hollow glass microbeads, vermiculite powder, chalk powder, talcum powder, pigment, bentonite, clay, diatomaceous earth and its mixture [15, 16, 18, 19, 23]. The inorganic minerals used can be calcined or uncalcined [24]

Stone paper that using pure-white silica powder as a substitute for CaCO<sub>3</sub> was claimed as green energy stone paper because at its' incineration process in incinerator, there was no acidic gas produced [15]. An attempt to replace all inorganic minerals with recycled fiber from waste paper was also reported. From this research, the stone papers with good physical and mechanical properties were resulted along with other advantages such as natural and energy resources saving, as well as low emissions [16].

Due to HDPE resins not biologically degrade at all, efforts also have been made to find alternative synthetic resins other than HDPE. This was also done in order to reduce production costs. Some of the alternative resins that can be used among others were low-density polyethylene (LDPE), linear LDPE, polypropylene (PP), polyethylene terephthalate (PET), polylactic acid resin (PLA), and waste plastic, recycled beverage bottles made of PET [17, 22, 23].

As stated earlier that stone paper is photodegradable; not biodegradable [3]. To overcome this problem, stone paper which can be degraded biologically through the use of completely biodegradable polymer as a carrier was also been developed [19]. It was proven that the use of polylactic acid resin (PLA) purified from natural starch as a substitute for synthetic resin produced biodegradable stone paper [23].

Other stone paper developments carried out were being in relation to improve the stone paper characteristics which were considered not in line with expectations. One of it was improving the ratio tensile strength and tear strength between longitudinal and transverse direction. The other effort was improving the fold ability of stone paper [18, 24].

## CLOSURE

The emergence of new papermaking technology innovations as an alternative to conventional process technology that has been known so far, is a breakthrough that increasingly attracts attention. Unlike conventional paper made from plant fibers, the main raw material for stone paper is inorganic minerals that are available in large quantities on this earth; mixed with a small amount of synthetic resin as an adhesive. The manufacturing process that does not use water at all with lower greenhouse gas emissions makes stone paper more environmentally friendly. In addition, stone paper has many advantages compared to conventional paper. Nevertheless, efforts to develop stone paper are still being carried out to improve various aspects, both for the purpose of technological improvements and to make stone paper more environmentally friendly.

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