COMPANY INFORMATION

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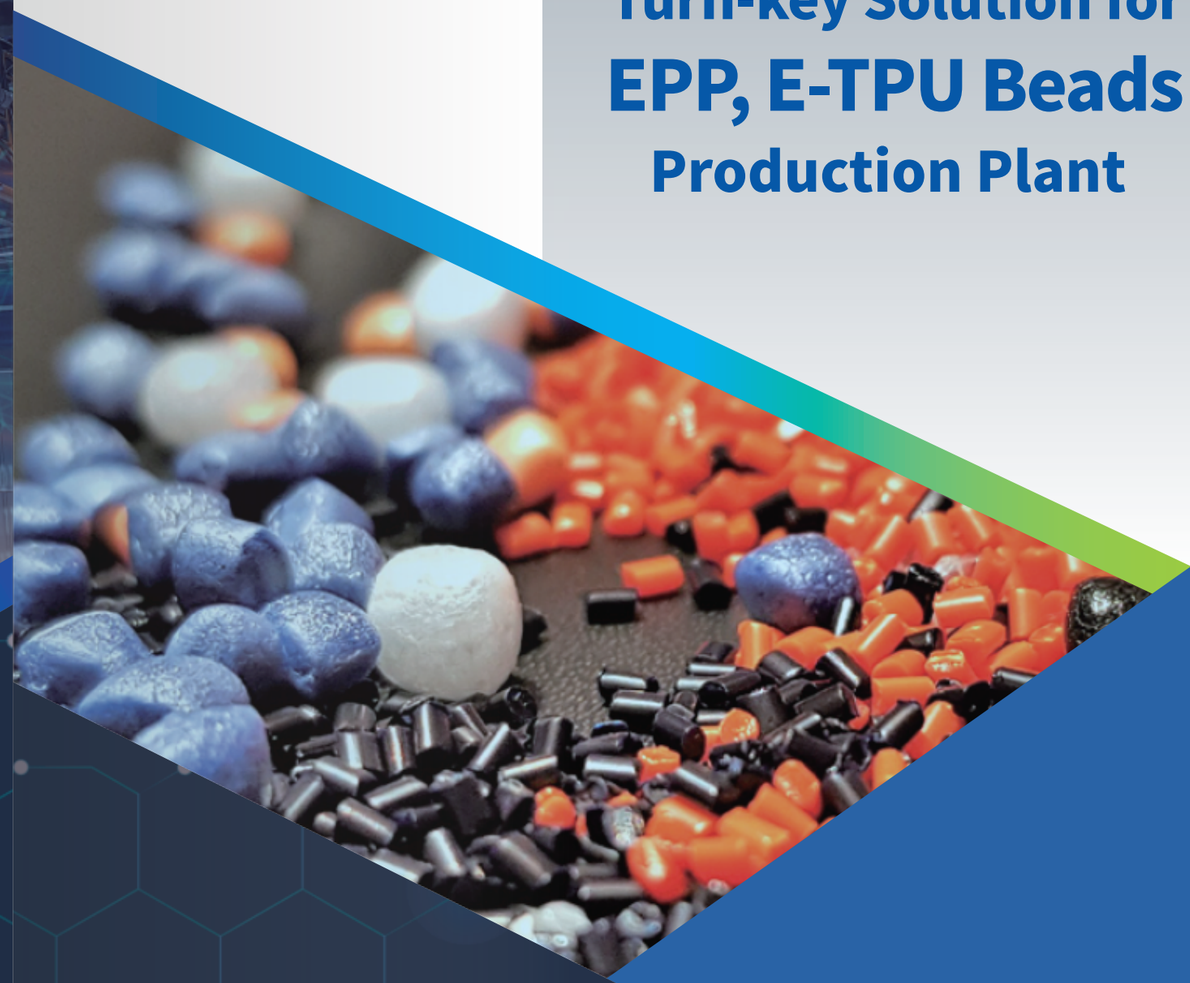
IMG PLASTEC
MACHINERY & PLANT ENGINEERING GROUP

Autoclave Technology

Turn-key Solution for EPP, E-TPU Beads Production Plant



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IMG Plastec Group,

Designing for a Sustainable Future

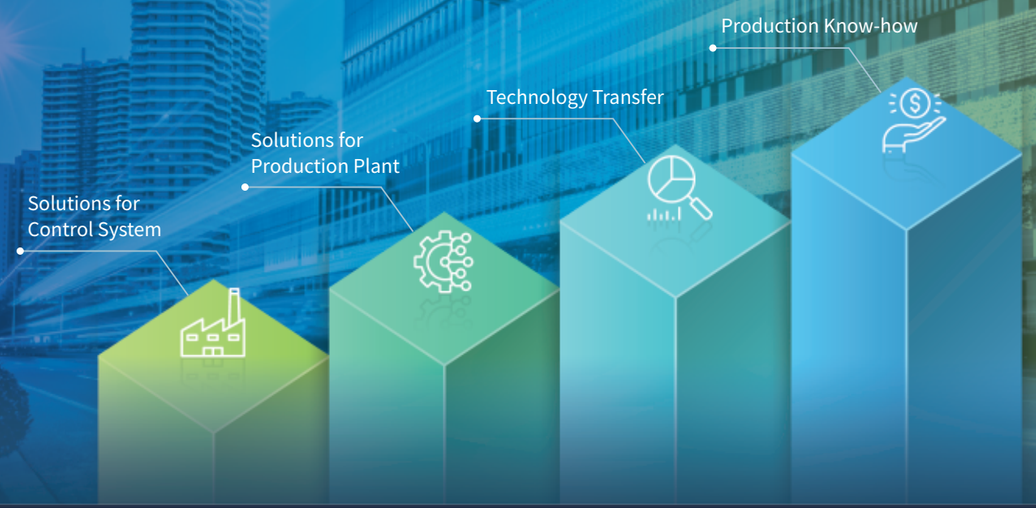
www.imgplastec.com

NO.1 Global Company

IMG PLASTEC
MACHINERY & PLANT ENGINEERING GROUP

"We are IMG Plastec, a global group. We promise to do our best for clients.

- Young G. Song / CEO -



WHO WE ARE:

The IMG Plastec Group started off as a beads foam production processing machinery and plant engineering company. Gradually, IMG Plastec developed to the core of an innovative and constantly expanding enterprise group. Today, the IMG Plastec Group supplies in two segments which are EPP and E-TPU foam beads production system and its complete know-how and technology.

WHAT WE DO:

In the future, most of steam chest molders will install EPP bead foam autoclaves directly in the plant and produce EPP beads by themselves, which will significantly reduce the price of EPP materials and shipping cost. The IMG Plastec Group is contributing to offer an effective and stable production environment to the clients by transferring accumulated technical know-how of EPP/E-TPU bead foam production system.

What is EPP?

EPP, also referred to as EPP bead or EPP foam, stands for Expanded Polypropylene foam bead. EPP bead is used in a wide variety of applications for packaging, buoyancy, insulation, protection, and so on. As product coverage increases in automotive, consumer goods, construction, packaging, sporting goods, toys and household goods, the reduction in material cost is expected to have a significant impact on the overall market growth in the coming years.

Toy	Consumer goods	Furniture	Car	Construction
				

The Future of Particle Foam

The Expert Interview with Professor. Chul B. Park

Q. The price of polypropylene (PP), the base material of EPP, is about 20–30% lower than that of polystyrene (PS), the base material of EPS. However, comparing the prices of EPS and EPP foam beads, the opposite is true. The price of EPP beads is about twice as high as that of EPS. Why is that?

A. Park : EPS pellets with impregnated pentane are produced directly from the pre-expander. EPS producers buy EPS pellets and use steam in a pre-expander to foam them. However, EPP (and E-TPU) is different. First, EPP (and E-TPU) Mini-pellets of about 1 mg are made through the extrusion process, and then the Mini-pellets are placed in a high-temperature and high-pressure autoclave, to be impregnated with CO_2, and to be expanded 5 to 30 times. A higher expansion ratio over 30-70 times, or even higher, can be obtained by using the steam pressure in the secondary foaming machine. On the other hand, PP has a sudden drop in viscosity when heated, and it is very difficult to form foam walls. Therefore, expensive manufacturing facilities with very precise and professional control systems for making two peak crystals in PP are required.

But these complicated processing technologies cannot justify the 2-fold EPP price over the EPS price. The EPP's high price basically came from the patent rights and the high cost for transportation of the expanded EPP beads. Until recently, global companies such as JSP, Kaneka, BASF, Hanwha, and Lotte had been exclusive suppliers, using the earlier patents around the world. But the patent has been expired, the steam-chest molding companies do not have to pay twice of the EPS price. The EPP cost will be significantly reduced if the molding companies make their own EPP foam beads to avoid the patent royalty and the unnecessary transportation costs.

Q. The main raw materials for synthetic resins in foamed plastics are polyurethane (PUR), PS, polyolefin and thermoplastic polyurethane (TPU). In addition, there are foam products such as extruded PS (XPS), PS paper (PSP), and crosslinked polyethylene (XLPE) foams that are made by the extrusion method. Also, there are foamed beads, such as EPP and E-TPU, which are blown by supercritical CO_2 in a high-pressure autoclave.

How do you predict the future development potential of bead foams using an autoclave?

A. Park : First of all, I would like to clarify that the bead foam technology is the ONLY method that people can use to make low-density foams with complicated 3D geometry. Foam beads can be inexpensively made, either by the autoclave technology or by the extrusion technology. The autoclave technology is very versatile and capable of independent control of the required properties of the EPP and E-TPU foam beads. The autoclave equipment is not that expensive either. The required two peaks of EPP will not be easily created using extrusion foaming technology. For E-TPU, the quality of E-TPU foam beads made from the extrusion technology may not be as good as that of E-TPU foam beads made from the autoclave technology. Therefore, I believe that the autoclave-based foam bead manufacturing technology is very promising for the future.

Q. You emphasized that all semi-crystalline polymers can be made into bead foams having double peak. In what direction do you think new materials that will receive attention will evolve in the future? Also, please tell us about the development of a new material that combines the advantages of EPP and E-TPU by adding nanofiber rubber to EPP.

A. Park : Because of the outstanding performance and the low cost of EPP, the EPP market will grow steadily with continuous development of various new applications requiring a wide range of different mechanical properties: (i) from very soft foam applications with high ductility (i.e., high elongation at break, high toughness and high impact strength), while sacrificing the stiffness, (ii) to very rigid foam applications with high stiffness while sacrificing the ductility (i.e., low elongation at break, low toughness and low impact strength). We could not achieve both high stiffness and high ductility at the same time using conventional materials. Normally, increased ductility will be accompanied by a major sacrifice of the stiffness. However, the new nanofibril rubber technology will enable us to achieve the ductility without sacrificing the stiffness.

Paradigm Shift of EPP Production System

"IMG PLASTEC is leading paradigm shift in particle foam production using autoclave technology."

" In the future, the EPP foam beads can be manufactured by the user (molder) to greatly reduce the EPP material cost, instead of depending on the monopolistic companies' tight operation. The autoclave-based EPP equipment will be supplied at a very low price, and the optimal foam processing conditions will be supplied free of charge, by applying artificial intelligence AI to the recently digitized plant, so that EPP foam beads can be produced easily and stably. "

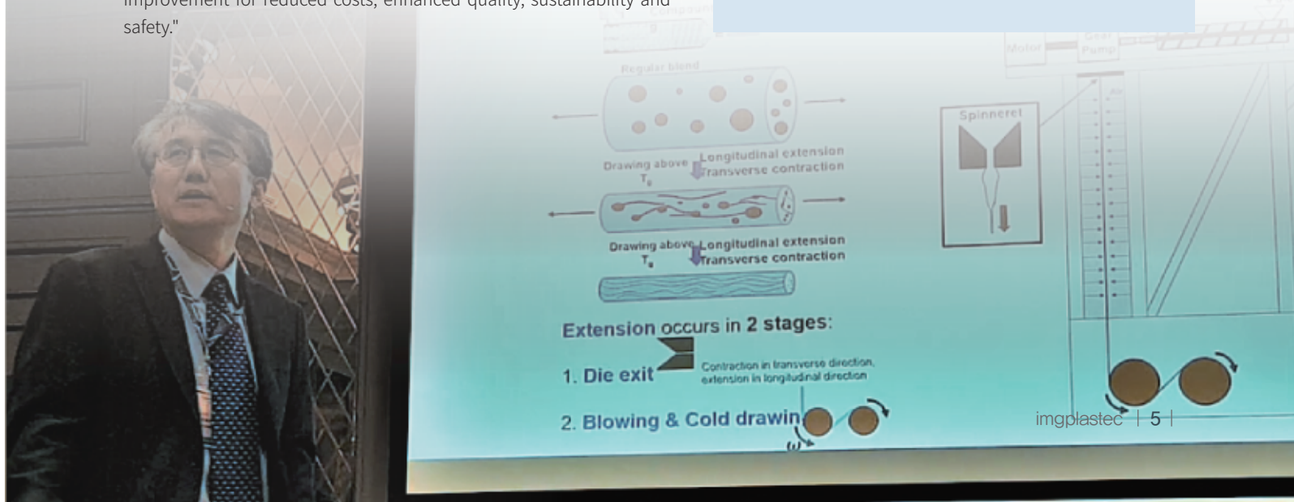
[CEO Young G. Song & CTO Chul B. Park]

CEO & Chairman Young G. Song has been researching and developing equipment-manufacturing and molding technologies for polymer foams over 30 years. He is currently distributing autoclave-based bead foam production technologies and facilities. In particular, he is supporting bead-foam producers, together with experienced professors and professional technicians in the foam field, to safely and cost-effectively manufacture EPP and E-TPU foam beads, while supplying a compact smart factory system that incorporates artificial intelligence, and state-of-the-art equipment.

CTO Chul B. Park Distinguished Professor of Microcellular Engineered Plastics at University of Toronto, received his Ph.D. from MIT in 1993. He serves as a consultant and the CTO of IMG Plastec. Prof. Park was a major inventor of MuCell Technology and has identified the fundamental mechanisms of cell nucleation and expansion. Especially, he elucidated for the first time the roles of the EPP bead's two crystal peaks in foaming. He has published more than 1,400 papers, including 420 journal papers and 4 books, with the h-index of 76. Prof. Park also serves as the Editor-in Chief of Journal of Cellular Plastics and sits on the Advisory Editorial Board of 12 other international journals.

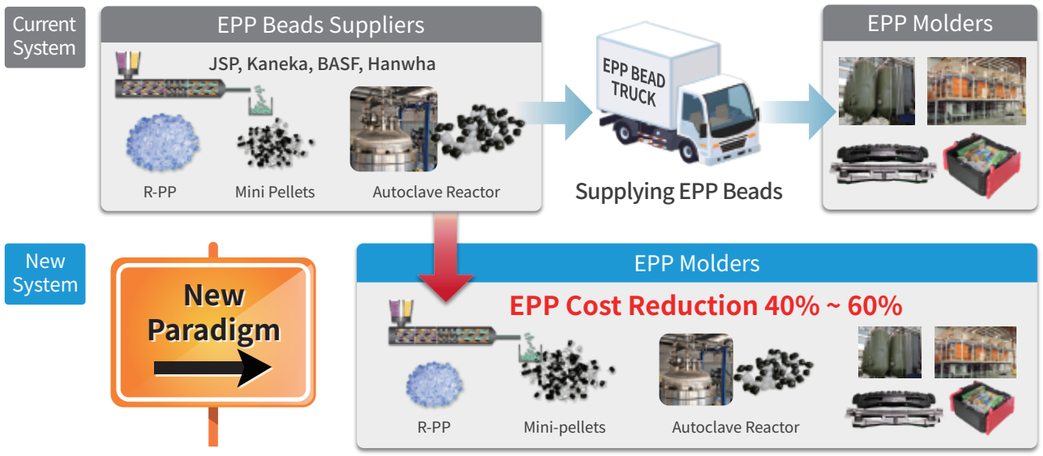
"In other words, the new nanofibril rubber technology will increase the range of new applications requiring both high stiffness and high ductility. Another advantage, especially for automotive applications, is decreased density with the same functions. A lower density rigid EPP foam having a small nanofibril rubber content will be able to exhibit the same properties as the higher density soft EPP foam and, thereby, we will be able to decrease the weight of the EPP products.

All semi-crystalline polymers can be made into bead foams having double peak with tailored properties. By producing such foam beads directly from the molding company, innovation can be easily brought to (i) the market development for new applications, (ii) the product development with desired properties, and (iii) the processing technology improvement for reduced costs, enhanced quality, sustainability and safety."



Paradigm Shift of EPP Bead Production System

Paradigm Shift of EPP Production System



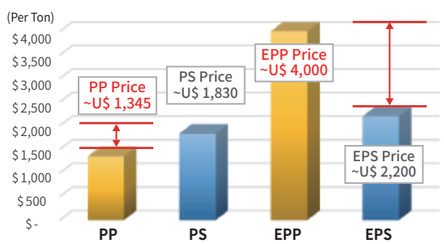
Price Comparison between EPP & EPS

The price of raw material of PP and PS has no big difference. However, the price of foamed EPP is much higher than that of EPS. It's because of the earlier patent rights, and high transport cost of the bulky EPP beads.

· **PS** Resin Price: Appr. **$1.80**	· **EPS** Bead Price: Appr. **$2.00**
· **PP** Resin Price: Appr. **$1.35**	· **EPP** Bead Price: Appr. **$4.00**

October 2018 (Korea)

EPP, EPS PRICE COMPARISON



ROI & Annual Saving Cost

If your factory produces 1,000 tons of EPP beads per year directly, you can save about $1,500,000 to $3,000,000 per year over the current purchase price, depending on the scale of your production. See the table below. When you directly produce about 1,000 tons of EPP beads per year, the ROI is about 75% to 150%. Your investment will be recovered in 1~2 years depending on the quantity of production.

Market Price: Appr. **$4.0~$5.5**

Direct Production Price: Appr. **$2.5**
ROI: **75% to 150%**

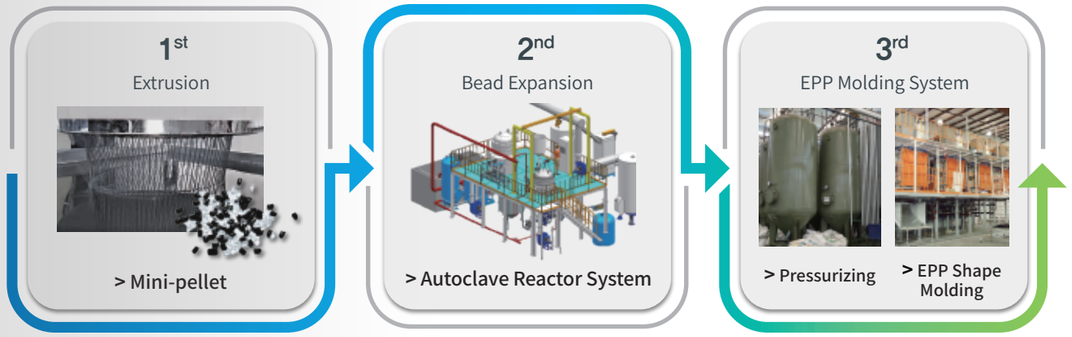
Production Volume (Year)	EPP Bead Foam Market Price & Amount		Self-Production Cost & Amount	④ Annual Cost Saving	⑤ Investment Amount	⑥ ROI
	① $4/kg	② $5.5/kg	③ Appr. $2.5/kg	⑦=③,④-⑥	Production plant	⑨=⑦/⑧*100
1,000 Tons	$4,000,000	$5,500,000	$2,500,000	$1,500,000 ~ $3,000,000	$2,000,000	75% ~ 150%

* Actual cost may vary depending on the regions, the price of raw materials, a type of additives and desired color of beads.

EPP Bead Foam Plant & EPP Products

The 3 Steps of EPP Bead Foam Production

1st Mini-pellet production, 2nd EPP bead expansion, and 3rd EPP molding process.

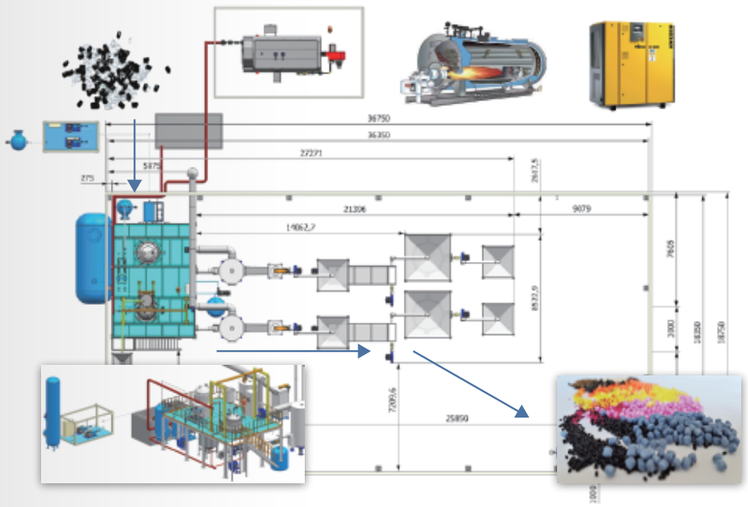


The first step in EPP production is to produce Mini-pellets through an extrusion process. In this process, important additives are added to create Mini-pellets with a weight of ~1 mg.

In the second process, water, additives, and Mini-pellets are put into an autoclave, heated to the melting temperature of PP. Then, CO_2 gas is injected to impregnate the Mini-pellets under pressure. Finally, the CO_2-saturated Mini-pellets are released to produce EPP beads with the desired expansion ratio.

The third process is to put the EPP beads in a pressure tank and pressurize for about 8 hours to restore the shrunken beads, and then inject them into the mold of the steam chest foaming machine to make the desired shape of the product.

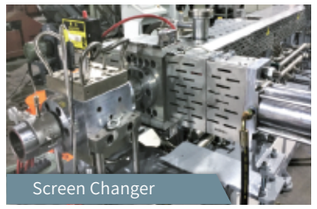
EPP Bead Plant Layout



Mini-pellet Extrusion Line

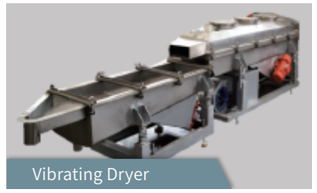

Gravimetric Blender


Twin-Screw Extruder


Screen Changer


Cooling Bath

Pelletizer


Vibrating Dryer

The first step in the manufacturing of EPP is the production of Mini-pellets through an extrusion compounding process. We can use a single-screw extruder in some cases, but a twin-screw extruder is typically used for most applications for compounding. The main ingredient of Mini-pellets is random copolymer polypropylene (R-PP). Special additives are compounded into R-PP in the compounding extruder. The additives include color master batch, cell enhancer, antistatic agent, nucleating agent, etc., and the amount is determined and mixed in an automatic gravimetric blender.

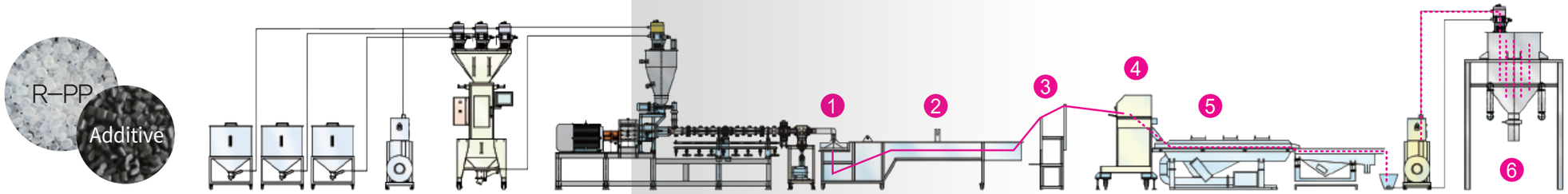
Mini-pellet Extrusion Line (IM-EXS100)

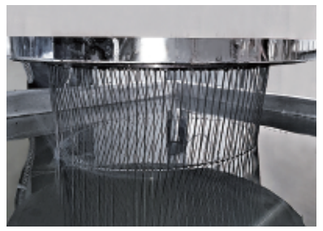
The blended materials are pelletized accurately to the desired size of ~1 mg. The most critical thing in the production of Mini-pellets is the know-how of the extrusion technology that includes special additives, the die head and the pelletizer to precisely and consistently cut the beads to the desired size.

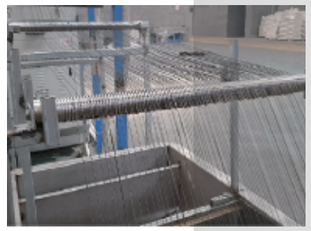
Function of the Downstream System

① Polymer strands extruded from a die head ②pass through the cooling trough. ③ The air knife ensures effective drying of strands prior to cutting. The residual moisture evaporates in the evaporation section. ④ The feed tools of the strand pelletizer catch the polymer strands and direct them to the cutting tools where the strands are cut into pellets. ⑤ The pellets are classified, cooled, and conveyed in subsequent operations. ⑥ The cut and dried Mini-pellets are transported to the storage silo by air blower and packed.

* Out put: Approx. 200 kg to 300 kg/hr




Die Head (100 lines)


Cooling Bath

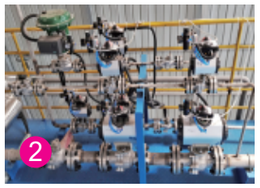

Mini-pellet Pelletizer

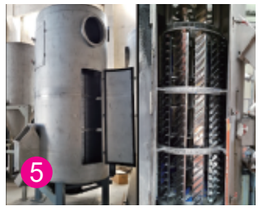

Dryer & Sieving Unit

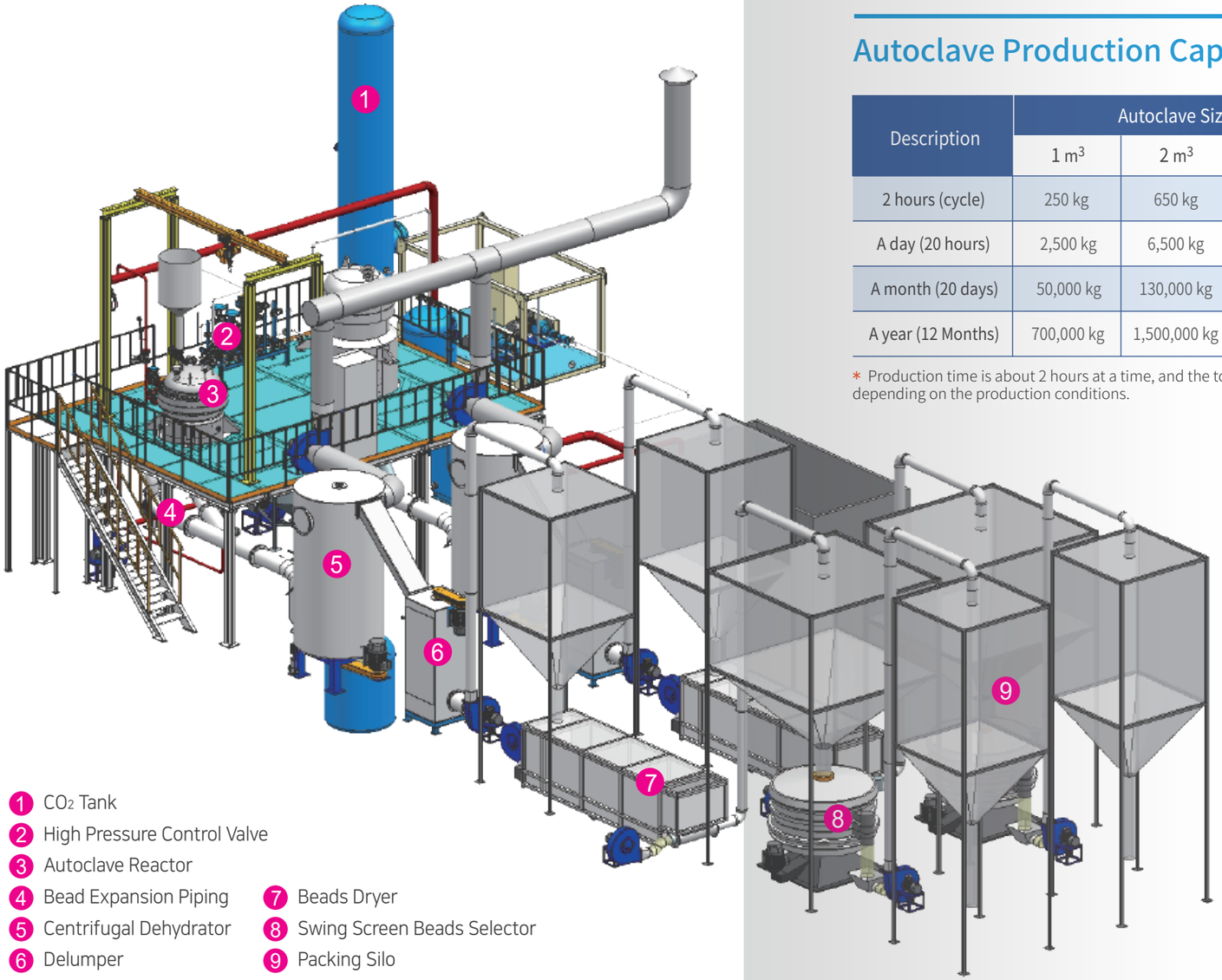

Mini-pellet Weighing
Roughly ~1 mg

EPP Beads Expansion System

First, EPP (or E-TPU) Mini-pellets of about 1 mg are made from the extrusion process, then the Mini-pellets are placed in an autoclave at high temperature and high pressure to be impregnated with CO_2 and expanded 5 to 30 times. A higher expansion ratio over 30-70 times, or even higher, can be obtained by using the steam pressure in the secondary foaming machine. On the other hand, PP has a very low melt strength, and it is very difficult to form cell walls. Therefore, expensive manufacturing facilities with very precise and professional control systems for making two-peak crystals in PP are required.







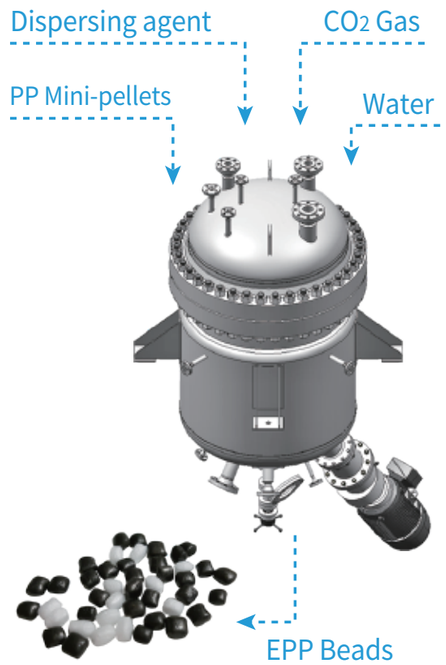
1. CO_2 Tank
2. High Pressure Control Valve
3. Autoclave Reactor
4. Bead Expansion Piping
5. Centrifugal Dehydrator
6. Delumper
7. Beads Dryer
8. Swing Screen Beads Selector
9. Packing Silo

Typically, two units of autoclaves are installed: one to make the main products and another to make small quantity products or spare parts. More units can be installed as needed. Conventional manufacturing process of EPP beads is a batch foaming process in which solid R-PP Mini-pellets are impregnated with CO_2 blowing agent for about 1 hour.

Autoclave Production Capacity

Description	Autoclave Size		
	1 m^3	2 m^3	3 m^3
2 hours (cycle)	250 kg	650 kg	1,000 kg
A day (20 hours)	2,500 kg	6,500 kg	10,000 kg
A month (20 days)	50,000 kg	130,000 kg	200,000 kg
A year (12 Months)	700,000 kg	1,500,000 kg	2,400,000 kg

* Production time is about 2 hours at a time, and the total output varies depending on the production conditions.



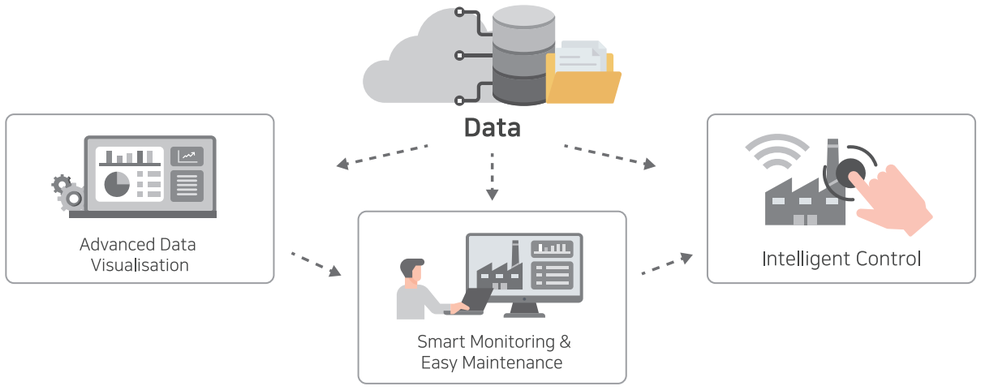
[Mini-pellets]

[Expanded Beads (EPP)]

Digitalization of EPP Plant

We provide a turn-key smart factory that provides optimal foam processing conditions to stably and cost-effectively produce EPP foam beads by applying artificial intelligence (AI) to the recently digitized factory in our autoclave-based EPP equipment.

Network System



Digitalization is noticeably changing our world – the world of industry. Enormous amount of data should be managed and archived in a long term. At the same time, each production process should be monitored and controlled in a reliable, efficient, and productive way, and constantly optimized in order to prevent variations and noise factors coming from materials and production environment. We offer an online control service by integrating all our machines and factories into the network so that errors can be found and corrected immediately.

SCADA System

What is SCADA System?

SCADA typically consists of a combination of software and hardware such as PLCs and RTUs. The data are collected from PLCs and RTUs that communicate with plant floor equipment such as factory machines and sensors. Collected data from the equipment are transferred to the next level like a control room, so that the operator can supervise PLC and RTU control by using HMI. The HMI is a screen which is a major element of the SCADA system to support communication between the operator and the system.

Factory Control

Installation Case

A Vision of EPP Bead Foams

In the future, the EPP foam beads can be manufactured by the user (molder) to greatly reduce the EPP material cost, instead of depending on the monopolistic companies' tight operation. The autoclave-based EPP equipment will be supplied at a very low price, and the optimal foam processing conditions will be supplied free of charge by applying artificial intelligence (AI) to the recently digitized plant, so that EPP foam beads can be produced easily and stably.

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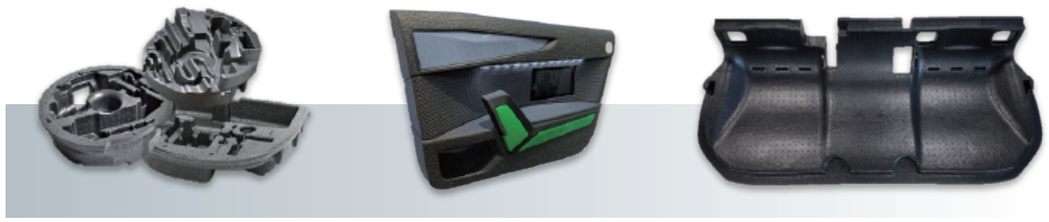
Application of EPP Products

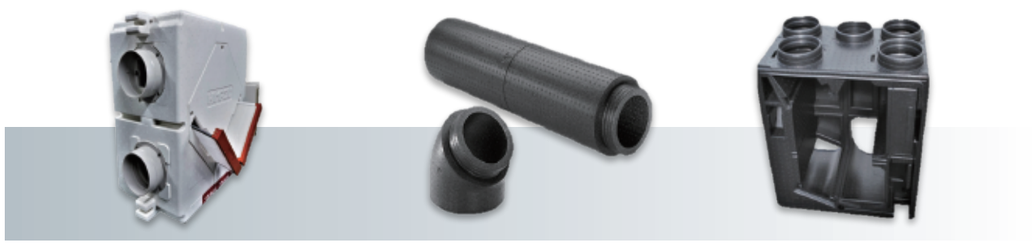
Technical Molded Parts

EPP is indispensable in several industries including car manufacturing. Due to EPP's outstanding energy absorbing property, EPP parts can improve passive safety and provide better protection for vehicle occupants. Accordingly, they are used to make fenders, headrests, and other impact absorbers. EPP can absorb even more energy when used in combination with metal.



EPP HVAC & Thermal Insulating

The thermal properties of EPP make it perfect for the heating, ventilation, air-conditioning and refrigeration (HVAC-R) industry.



EPP Health & Sports

EPP has been used to make a variety of health and sport products: climbing, skiing, horseback riding, skateboarding, surfing, baseball and cycling helmets, ski boot insoles, body boards, swimming floats, body protection, shin pads, bicycle rims, athletic yoga rolls, etc.

EPP Electronic Packaging Products

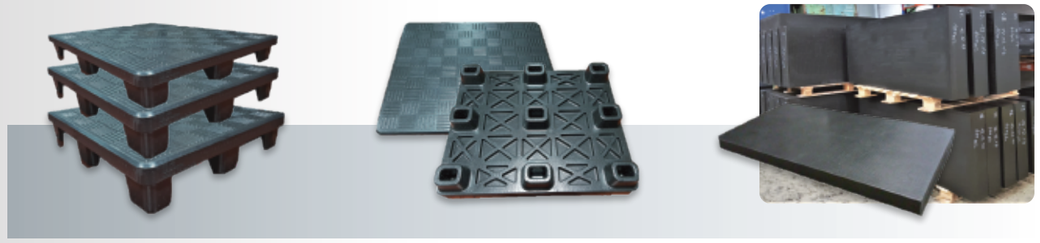
General packaging and anti-static packaging of electronic goods.

EPP Beehive

EPP hives, which have been widely spread recently, solve the problems of the existing hives and ensure a comfortable life for bees, especially in extreme cold and humid weather. Because of the easier maintenance and the higher harvest of honey over 30%, beekeepers came to actively use EPP hives.

EPP Pallet & Plank

EPP pallets are perfect alternative to EPS because they are made out of eco-friendly material. Additionally, they are durable and sturdy, and the maximum load weight is around 3,000kg. EPP planks are not only lightweight but also strong enough to protect more products.



Application of EPP Products

EPP Furniture, Bean Bag Filler

The EPP furniture is lightweight, so it is easy to move and assemble even for children. Also, EPP materials are environmentally friendly and 100% recyclable, thus it's considered perfect for furniture for kids. Due to its durability and various colors, EPP is widely used for a chair, a bed, and a mattress, to name a few. EPP furniture has both practicality and aesthetics, therefore, related market is expected to grow steadily in the future as well.

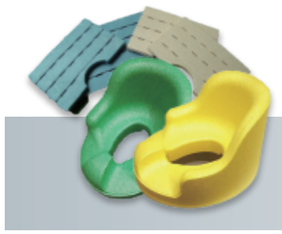

EPP Leisure

Numerous model airplanes, artificial turf and playing pieces have been made out of EPP because of the safety, lightweight, and excellent mechanical properties.



EPP Home Applications

EPP products are used for many home applications such as baby hip seats, ironing boards, bathroom mats, cushion mats, children's toilet seats, flowerpots, stationery desk mats, wine cooler, etc.



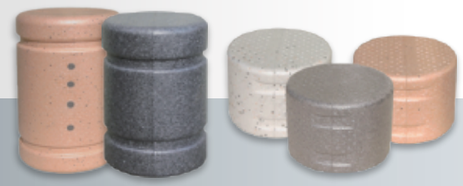
EPP Hot, Cold & Fresh Food Box

EPP BOX is a revolutionary new EPP series of containers with a high density in which hot or cold items can be transported with an average temperature loss of less than ±1°C plus or minus per hour within a temperature range of -40°C to +120°C.



EPP Buoys

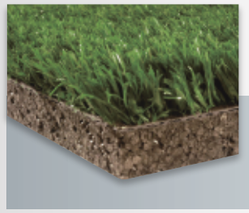
EPP is the most suitable material for buoys because it doesn't contain heavy metals which are harmful to the marine life. Also, EPP buoys are durable, so their cracking (and thereby marine pollution) will be minimized.




The Others

In addition, EPP is used as a material for mannequins, sports equipment, various parts for automobiles, kid's cafes and playgrounds, or furniture and products used at homes and offices, etc. In particular, EPP has excellent and various mechanical properties, which is very fascinating for the producers whose products require a combination of more than one mechanical properties.

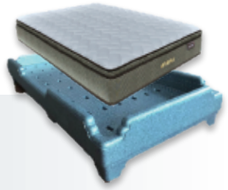
[Ground Plates]



[Flowerpot]

[Toys]

[Bed & Mattress]



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MACHINERY & PLANT ENGINEERING GROUP

What is E-TPU?

E-TPU stands for Expanded Thermal Polyurethane which is a polyurethane-based thermoplastic elastomer. E-TPU beads can be made through expansion of the air, and the size of the expanded beads could be 5~10 times bigger than the one of original beads. They have numerous cells with a diameter range of 30~300 μm with a plenty of air inside. E-TPU is widely used for the applications requiring high durability due to its astonishing mechanical properties such as tensile strength, tear strength, abrasion resistance and so on.

E-TPU Characteristics

Eco-friendly ETPU materials fully meet the criteria of EURoHS (a restriction of using harmful components in electronic devices) and other regulations. In addition, ETPU materials are completely recyclable, which is a definite advantage for environment protection.

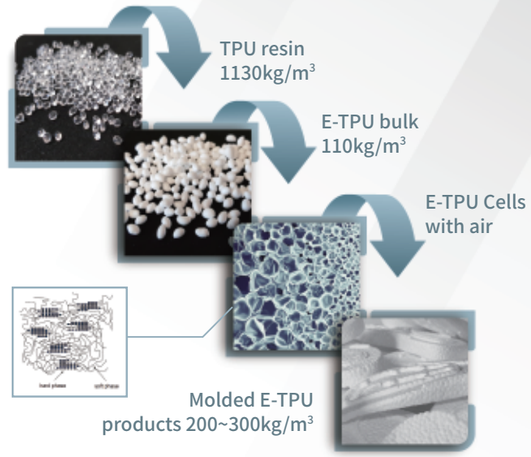
- Low density (Ultralight)
- Great chemical resistance
- High tensile strength
- Durability in wide range of temperature
- Outstanding resilience
- Eco-friendly material
- High elasticity
- High abrasion resistance

E-TPU's Elasticity & Its Principle

The Principle of Elasticity of Expanded Thermoplastic Polyurethane

After pre-treatment to granules of TPU beads by pressure heating, each of TPU (thermoplastic elastomer material) particle expands like popcorn. In this process, the original particles with size of 0.5mm can expand to 10 times bigger, and finally turn to E-TPU, an oval and non-crosslinked foamed particle, which contains micro-closed cells that look like “popcorn.”

During the expansion process in autoclave, TPU beads are heated at 150°C, the softening point of TPU. CO_2 blowing agent is impregnated into Soft Segment (SS) which results in expansion of TPU and arrangement of crystal domain of Hard Segment(HS). This is the basic principle of excellent elastic property of E-TPU.



Application of E-TPU

E-TPU for Shoes

Shoes are essential to keep proper body activities which are very important for our health. It is one step ahead of technology trend to apply E-TPU to the midsole of shoes.


[Midsole shoes]


[Golf shoes]


[Safety shoes]


[Insole]

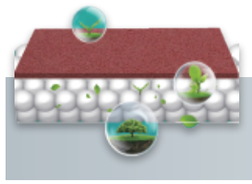

[Running shoes]

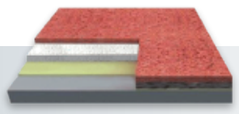

[Snowboard Boots]


[Sandals]

Track & Playground

Outstanding shock absorbing property of E-TPU foam offers a safer and better environment of running track. Due to the protective function of E-TPU, it is widely used in kindergarten or playground for children.





Bicycle Parts & Protective Gears

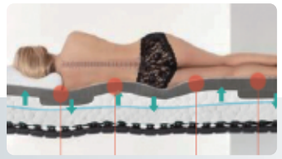
E-TPU has an outstanding shock absorbing property, thus it's used for the bicycle parts and protective gears. Particularly, movable E-TPU bicycle saddle provides a stable riding environment even in a long trip by absorbing the shock from the uneven ground.

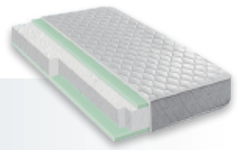
Airless Tire for Electronic Vehicle & Bicycle

E-TPU is abrasion-resistant and resilient, which can eliminate discomfort caused by puncture of pneumatic tires. By replacing existing tires with EPP, we can enhance the safety for electric vehicles for the disabled.

Mattress

With high elasticity and resilience, E-TPU absorbs impacts and adjusts to our body thus reduces the pressure on the spine but gives comfort for relaxing and deep sleep.

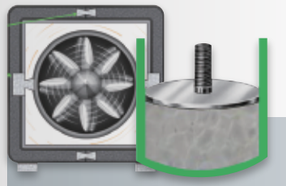




The Others

E-TPU can be used for whatever requires a combination of mechanical properties such as light weight, curability, resilience, etc.

[Industrial Anti Vibration Pads]



[Toy Ball for Pets]

[Machine Suspension]

[Gym Floor Mats]