

Kneading - Mixing - Drying

**Recycling Plastics**  
*with LIST KneaderReactors.*

# Recycling Plastics

**Everybody uses plastics every day, whether it's in our cars, at home or at work.**

It's understandable why the properties of this material make it extremely useful and versatile: it is easy to shape, relatively light, and inexpensive. Nevertheless, we are all aware of the disadvantages of plastics; especially when they have reached the end of their lifespan, as they are either used to generate energy, dumped in large quantities in landfill sites or into the sea.

In addition to avoiding using plastics to make disposable products, recycling is an important way to reduce waste in the economic value chain.

One possible method is to separate the plastic waste via thermal processing in extruders. This process however has one major downfall: it leads to the deterioration of the original properties of plastic as a result of the excessive shear forces and temperature peaks, meaning it reduces, among other things, its molecular weight and therefore its future possible uses.

Other processes designed to completely restore the original properties of the plastics include pyrolysis in combination with naphtha cracking to create a new product for chemical processes, depolymerization to convert polymers into monomers, and dissolving plastics into solvents and then drying them.

## Efficient Processes with LIST KneaderReactors

In recent years, LIST has successfully implemented a variety of recycling processes together with customers and developed new processes.

The competence and experience behind our process development and possibilities in our technical center, which is capable of handling continuous or batch processing at a rate of 100 kg/h providing the basis for developing recycling processes that can be scaled up with a throughput guarantee for the customer.



## LIST KneaderReactors for Solid and Liquid Educts and Products

We use kneader reactors that can process fluids with very high viscosity and safely handle phase transitions to free-flowing solids to treat residues.

This means we are able to process both the condensate, which is recovered from the viscous phase at very high recovery rates of up to 98%, as well as pasty or free-flowing products, which are continuously discharged from the kneader, usually using a twin-shaft screw discharge, after the thermal-mechanical separation process. Using the kneading process reduces the amount of plastic that is sent to landfill sites or incinerators.

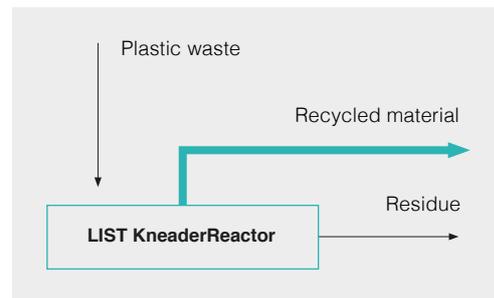


Figure 1:  
Example diagram  
for monomer recovery  
from plastic waste

LIST KneaderReactors operate with a vacuum of up to 1 mbar absolute pressure, in the overpressure range and at temperatures of up to 350°C. Heat is transferred via heating surfaces of up to 200 m<sup>2</sup>. The continuous exchange of material (especially in the viscous phase) generates very high heat transfer values (k-values) on the heat-transfer surfaces and guarantee the stable transfer of heat.

In contrast to extruders, LIST kneaders can realize long residence times that are largely independent of the shaft speeds, resulting in complete separation even with large throughputs on just one production line. It is also still possible to control residence times in plug-flow operations, ensuring minimal degradation of even sensitive polymers.

Furthermore, the shear force in kneader reactors lies at a power of 10 to 100 times less than those on an extruder, meaning the degradation of the polymers is reduced to a minimum. Both methods guarantee the very gentle processing of polymers in the kneader reactor.





**LIST Technology Test Center**

The combination of the processing liquids with viscosities greater than 50,000 Pas and free-flowing solids also facilitates the processing of particle-filled polymers.

Maximum surface renewal resulting from the intensive mechanical kneading action is a decisive factor for the high thermal separation effect, in particular of viscous media and solvents or polymers and monomers. The volatile substances are exposed to the surface from the viscous matrix and can be vaporized over the entire length of the process.

The closed design of the system together with the recondensation of the solvent ensures the process is safe and environmentally friendly. High recovery rates with maximum energy efficiency are achieved thanks to the technical possibilities of the LIST kneader, thereby offering maximum yields for reasonable budget.

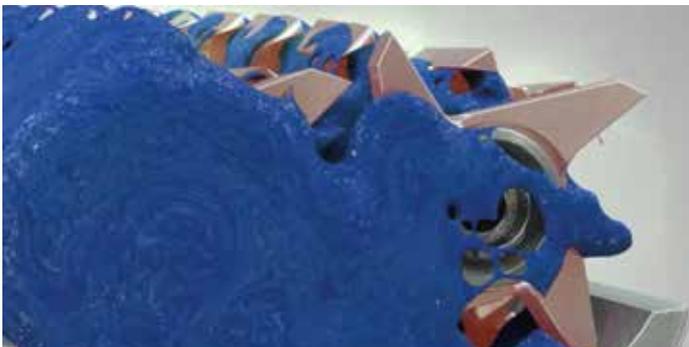


Figure 2: Surface renewal in the LIST Twin-shaft Kneader

## Thermal-mechanical Separation from EPDM Solutions in the LIST KneaderReactor

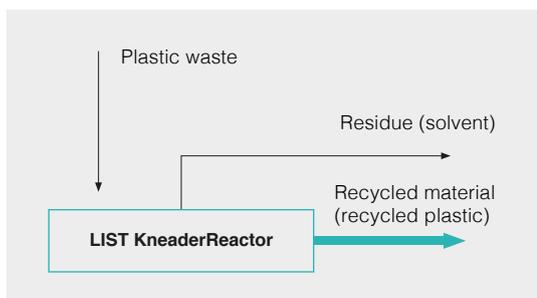


Figure 3: Separation equipment in the LIST KneaderReactor for polymer recovery

The solvent-based separation of plastics (elastomers) in LIST KneaderReactor is ideally demonstrated through the separation process of EPDMs and solvents, which we have protected in patent EP 0 910 588 B2.

A solution consisting of 20% solvent and 80% EPDM is continuously supplied to the kneader and concentrated up to a residual solvent content of 0.5%.

The elastomer is continuously discharged from the kneader reactor in the process room via a special discharge screw developed in-house by LIST. The illustrated, patented process is industrialized to attain a product through out of up to 10 t/h EPDM and reflects a typical separation process, which can also be applied to recycling processes.

With the LIST KneaderReactor technology, we are able to supply material for the polymer and elastomer industry without compromising its quality.

Furthermore, LIST technology fills the gap in a closed material circuit providing a polymer that can be reused according to specifications after being processed on LIST kneaders. We provide highly energy-efficient and robust recovery technology to help you keep costs low and output high.

## The LIST benefits for our customers

- High viscosity technology for the recovery of resources
- Very high throughput thanks to large-volume process units
- Flexible throughput for different levels of utilization
- Efficient, cost-effective waste treatment
- High-quality and pure products resulting from a high partition ratio

## How you can work with us

Our experts in thermal separation technology will answer any inquiries you may have about developing a solution to suit your recycling process.

We can draw up a resilient concept with the help of our process development system and the option to run tests in our technical center, so you can use your ideas in an industrial production environment. We support you every step of the way, ensuring all requirements for the process are met.

**Put us to the test. We look forward to hearing from you.**

**LIST**



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A Jakob Müller Company



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