ANDERSON
INTERNATIONAL CORP

Inventors of the Expeller Press®/Expander-Dryer®

ISO 9001:2008 with Design Certification

ANDERSON INTERNATIONAL CORP.
POLYMER FINISHING LINE EQUIPMENT

- Synthetic rubber finishing
- Process description
- Polymers processed
- System capacity ratings / guarantees
- Equipment listing

The following information is provided to prospective new clients and/or representatives, solely for their own use to better understand Anderson's capabilities in polymer finishing line equipment. Under no circumstances is this document to be reproduced in complete or sections of, without the written consent of AIC. The information contained in this document is proprietary and not for publication or distribution.

What Constitutes a Rubber Finishing Line?

A rubber finishing line is engineered to separate the rubber crumb from the process water, and to produce either bales or bags of dried finished rubber.

The systems are very similar for both emulsion or solution polymerized rubbers. In some cases, both emulsion and solution reactor lines are processed on a common finishing line.

Following latex coagulation (emulsion) or steam stripping (solution), the crumb slurry is pumped or overflowed from tanks to dewatering screens that effectively remove the free water.

Following the mechanical dewatering and drying phases the crumb has been reduced from about 95% moisture down to 2% or less. All in just a few minutes!

The porous crumb is then conveyed along a vibrating conveying system for final moisture reduction, cooling and elevation for packaging.

Typically either a baling or bagging packaging system is installed immediately following the vibrating conveyor system. In some cases, where multiple polymer processing is accomplished on a common finishing line, both baling and bagging system are incorporated.

Typical baled rubbers are EPDM, Butyl, Polybutadiene, SBR, Polyisoprene, etc. In most cases high styrene rubbers and styrene copolymers such as SBS and SIS (TPEs) are immediately bagged after cooled.

Process Description

Free water draining:
A rubber crumb slurry containing between typically 5% to 10% solids is fed to the finishing line "Dewatering Screen". The crumb should be maintained at the highest possible temperature, preferably between 80°C to 100°C for best results.

The dewatering screen area must be adequate to drain off all free water thus increasing solids consistency to approximately 50%. This dewatered crumb is then fed directly to the feed hopper of the "Expeller®" press.

Mechanical dewatering:
By restricting the flow of rubber through the "Expeller®" die plate (hydraulic choke control), work is put into the rubber and internal barrel head pressures are effectively elevated to between 15 to 40 bar.

The combination of the interplay of the rotating flights and stationary knife bars (kneading action) and developed head pressures, moisture is pressed from the rubber and exits through the open gaps designed into the Expeller® barrel. The gaps can be easily adjusted to suite individual processing needs and eliminated all together in the areas of high pressure.

The rubber is cut into small manageable wafers as it discharges from the die plate. Ideally the dewatered wafers are dropped immediately into the Expander-Dryer® feed hopper. The discharging product is now higher in solid content and will typically contain between 8% to 12% moisture. Temperature rise is minimal between Expeller® feed

and discharge. The low shearing action will prevent any noticeable drops in the mooney viscosity.

Moistures are controlled by adjustments in hydraulic choke, feed rate, and in some cases by changes in the shaft speed. The polymer and dryer type determine the acceptable moisture level required through the dewatering stage.

Mechanical dryer:
The material is conveyed immediately into the feed section of the "Expander-Dryer®" barrel. The conveying section effectively begins to masticate the polymer (kneading action) which will result in a reduction in the polymer viscosity. The friction between the rotating flights and the polymer in this section will begin to gradually increase the polymer temperature.

In the discharge section of the Expander-Dryer® 2nd stage barrel a solid plug of polymer is formed due to the restriction in the die plate inserts. In this section the work put into the polymer increases exponentially and final polymer viscosity reductions are done and required process temperatures are developed.

In the discharge section the polymer will go through its final phase change, thus developing the necessary polymer consistency to begin and maintain an even flow of heated polymer through the small shearing die inserts. Head pressures and temperatures that are required for effective flash evaporation drying and cooling are controlled through adjustments in % moisture in the feed stock, die type and area and shaft speed.

Normal head pressures are 20 to 60 bar during normal operation but can exceed 100 bar at startup. Head pressures will vary between polymer type, temperature and starting fluid, if any, is being used.

As the pressurized heated polymer is extruded through the shearing die inserts, the pressure drop immediately converts the heated liquid to steam and it flashes from the polymer. Although head temperatures are typically between 150°C to 200°C, the evaporative cooling effect of the steam flashing from the polymer causes an

immediate drop in temperature in the range of 40%. This immediate cooling phenomenon prevents over temperature degradation.

The Expander-Dryer® die plate and cutter head are completely enclosed inside of an Anderson "Hot Box". The Hot Box is designed to contain the porous cut polymer pellets and gases while also maintaining an internal ambient temperature of between 120°C to 140°C. At this point the moisture remaining in the polymer is normally 2% or less but is no longer bound in the polymer making it very easy to remove during conveying to the packaging system.

Vapor exhaust and pellet containment and conditioning:
The Anderson Hot Box design will effectively contain the polymer and hot gases discharging from the Expander-Dryer® die plate. By adjusting the airflow between the heating input blower and exhaust blower to produce a negative pressure inside the Hot Box, the hot gases exploding from the polymer are effectively contained and removed from the process stream.

The ambient temperature inside of the Hot Box is maintained at between 120°C to 140°C to prevent the re-condensation of the moisture vapor back into the dry polymer. The gases are then immediately exhausted off and the porous dry polymer is conveyed through the Hot Box to the Spiral elevator.

Depending on the polymer type and process conditions, up to 95% of the polymer bound liquid is converted to a gas immediately at discharge from the Expander-Dryer® die plate.

The violent conversion of liquid to gas produces a porous pellet that retains a very small amount of moisture that is then easily evaporated out of the product as it is conveyed to the packaging system.

Crumb rubber / pellet conveying:
Ideally the dry crumb will be gradually cooled as it is conveyed to the packaging system. Vibratory conveyors are most commonly used for conveying crumb rubber to help produce a more evenly cooled product, to prevent polymer "cold flow" and reduce rubber sticking to conveyor decks. Heated process air is directed to the top of the Spiral

conveyor trough through nozzles to condition the rubber crumb just prior to the weigh scales and reduce moistures if necessary.

Maximum reasonable temperatures are maintained to ensure minimize bale cycling times. The moisture levels in the finished bale is normally required at 0.5% or less for most all polymer types. Some TPE grades will contain 1.0% or less in the pellet prior to bagging, which meets acceptable industry standards.

To further reduce polymer sticking to the conveyor decks they are commonly coated with Teflon.

Packaging systems:
A vibrating feeder conveyor is used to feed both baling and bagging systems. The feeder is driven at "full-feed" and "dribble-feed" rates as is determined by the weigh scale controller. The feeder is also designed with a dynamic braking device for controlled shutoff of product flow to the scale.

The weighing system must be interlocked with the baling and bagging systems to ensure smooth operation and accurate weighments.

Successfully Dewatered & Dried on Anderson Finishing Lines

>BR	>SSBR	>ESBR
>IR (polyisoprene)	>EPM/EPDM	>IIR (Butyl)
>CIIR (Chlorobutyl	>BIIR (Bromobutyl)	>SBR
>NBR	>PVC/NBR (blends)	>TPEs
>HSR (hi-styrene)	>Fluorinated rubber	>CR (Chloroprene)
>Acrylic rubber	>Block copolymers	>Natural rubber
>ABS	>SBS	>PVC

Anderson Finishing Line Capacities

Capacities are based on the model and design of the equipment installed, connected horsepower, crumb slurry specifications and polymer type. Polymers are generally characterized as "easy flow / good expansion" to "hard flow / low expansion". The figures below are based on expected capacities (based on dry polymer weights) for both easy and hard to process polymer types.

(Type of line)	(Metric ton / hour, dry base)
➢ Model Finishing Line:	0.25 to 1.0
➢ No.8 Finishing Line:	0.5 to 2.5
➢ No.10 Finishing Line:	1.5 to 4.5
➢ No.10A Finishing Line	2.5 to 7.0
➢ No.14A Finishing Line	4.0 to 10.0

Finishing Line Guarantees

Anderson will guarantee final product moisture and capacity based on the polymer to be processed and the ultimate scope of equipment and technology supplied by Anderson.
For example, Anderson will only guarantee the process to the extent of our supply. If a new finishing line is to be installed and our scope of supply is restricted to the Expander-Dryer®, then moisture guarantee would be based at the die plate and not the finished bale of rubber. In this case our guarantee would be in the 2% to 3% range and not 0.5% or less as would be expected in the finished bale.

Polymer Division Equipment Listing

Anderson manufactured equipment:

- Expeller® presses:
  - Model No.6
  - No.6
  - No.7A
- Expander-Dryer®:
  - Model No.4-1/2"
  - No.8
  - No.10
  - No.10A
  - No.14A

- Skimmer Tanks
  - No.25
  - No.26
- Hot Boxes
  - No.10A Hood
  - No.14A Hood
  - No.10-10 TPE Hood
  - No.14-10 TPE Hood
  - No.10A High Corrosive Environment
- Pelletizing Cutter Systems
- Finishing Line Control Systems

Finishing Line Equipment Manufactured by Others to AIC Specifications, Performance Guaranteed by Anderson:

- Dewatering Screens
- Horizontal Vibrating Conveyors
- Spiral Elevators and Heating & Cooling Systems
- Vibrating Feeder and Transfer Conveyors
- Baling Systems
- Pellet Bagging Systems
- Weighscales
- Checkweighers
- Metal Detectors
- Bale Wrapping Systems
- Bale Conveying Systems