Pneumatic Transport Systems For Coffee Factories.

‘Pneumatics’ is the term used to discribe the transport of granular materials on a blast of air. For transporting coffee this occurs at an air pressure of around 1-3 metres water guage.

In contrast, the process of ‘conditioning’ uses a very small pressure differencial of only a centimeter water guage at most. It is very slow and even, and the whole bin or bed of coffee is dried very evenly without any surges in the moisture content of the coffee. Because coffee is the only commercial ‘grain’ that has its quality assessed in terms of its aroma and flavour, rapid and prolonged changes in temperature and moisture content, considered O.K for rice, wheat and other grains, must be avoided where ever possible for coffee. Transportation by pneumatics however, takes place very quickly, in a matter of a few seconds, and in such a short space of time quality and flavour damage is infinitesimal! The maximum temperature rise during pneumatic compression is only around 5 degrees Celsius.

A further point in regard to the quality of aroma and taste is the matter of metal silos. It may appear be cheaper or quicker to buy in commercial grain silos, which are made circular and corrugated, to conserve on weight of metal in stand alone situations. The advertising for pneumatic transport systems, used in temperate climate grain harvesting, as illustrated below, tends to link these two systems together.

Because they are water tight in terms of rainfall etc., the prevailing tendency is to think that they don’t need a building for protection and they can be placed outside. This however will allow large daily temperature fluctuations, mostly with direct sunlight on the metal surfaces. This not only makes them pump humid air in and out every day, but also creates temperature gradients between the centre and the walls of the metal bin, which makes them move moisture around inside the bin itself. All of which is damaging to the finer qualities of good Arabica coffee.

Once the need for a separate roof is admitted, to minimize on solar temperature fluctuations, it them becomes primarily a matter of floor space, and cylindrical silo’s not only take up much more floor space, but they also become relatively more expensive because they cannot share wall materials between bins, because of their separate circular construction.

Back to Pneumatic transport:

Pneumatic systems can operate with both positive and negative pressures, and have wide applications.

Applications

The TRL high-pressure blowers are suitable for a variety of applications and can form part of many flexible package solutions.

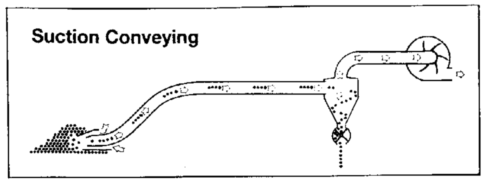
The high-pressure blowers are available in a wide range of sizes to match any specific conveyance requirement.

The use of the TRL high-pressure blower for conveying purposes ensures an entirely self-cleaning system which is not limited by the lay-out of the flow arrangement - whether vertical, horizontal, around corners or from one building to another. The system is ideal for farms requiring flexibility in conveying and processing different crops.

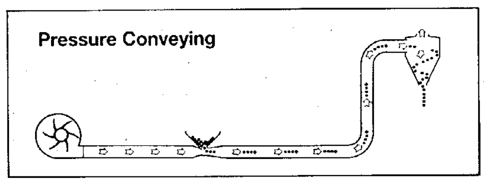
The range of accessories comprises rotary valves, cyclones and pipe systems, permitting utilization of the high-pressure blower for pressure and suction conveying, drying, cooling and ventilating of crops.

The OK connections are common to all pipes, bends and other components, allowing them to be combined in a countless number of ways, with easy assembly by means of the OK quick-release couplings - without the use of tools.

Operating Principles



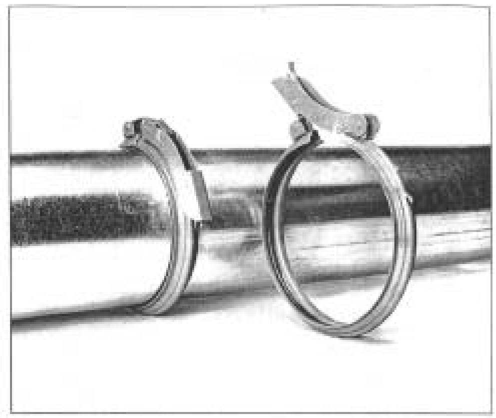
Suction is used, for instance, when the material is delivered to a cleaner. At the same time, part of the dust is separated from the grain. The crop is sucked from the grain pit or store using a suction head. The material is pulled through the pipe system and is delivered to the cleaner via a cyclone and rotary valve. The dust may be discharged to the open or to a set of filter bags.



The conveying line is connected to the blowers outlet. The blower generates a powerful air stream through the pipes. The material to be conveyed is fed into the pipe system via an intake unit (venturi or rotary valve). By means of diverters the flow may be directed to different destinations.

Pneumatic transport systems use thin light weight metal tubes along with all sorts of fittings such as bends, Ys, Ts, Caps etc. You can paint the outside, but you must use bare conductive metal on the inside. This is to negate the effects of static electricity. Rubbing dry coffee parchment together is just like scuffing ones slippers on a dry carpet. You can get sparks and the possibility of dust explosions if static charges are allowed to build up. The use of long plastic pipes therefore, is not a good idea, except in extreme emergencies. The exception to this rule is the use of flexible suction nozzles, because the material has not traveled far enough to generate any static effects.

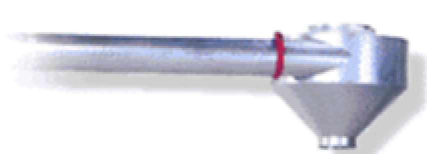
The pipe system comprises a wide range of straight pipes, bends, diverters, hoppers, cyclones, suction heads, etc. Assembly is effected by means of the patented OK quick-release couplings without the use of tools. See special brochure.



The patented OK quick-release coupling with lock ensures reliable connection during use and quick and easy adjustment of the equipment to different applications.

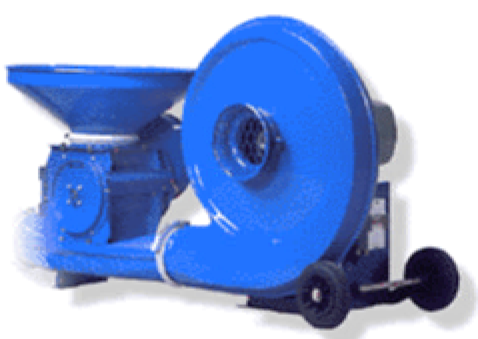
By use of the 'flip flop' three way diverters illustrated above, it is easy to set up a single pipeline with a pair of these, which can be diverted to or from up to five or more different dryers or bins at the flick of the central tube to the left or right. In the case of a line up of conditioning bins, run lines of matched short lengths of tubing, in both the top and bottom corridors. Each section of tube should be suspended, for and aft, on about 1.5 to 2 metres lengths of rope or wire, just like the desktop pendulum toys with 5 balls that can be parted and let collide in all sorts of combinations. At the appropriate bin each pipeline is separated, pushed apart and a filler tube is fitted into place. This consists of a 90^0 bend, a short length of tube to divert the pipeline into the center of the appropriate bin, and a short cyclone,shown below, to spread the coffee all over the surface of the bin. To empty a bin, a rotary or venturi valve unit can be inserted in the appropriate spot on the bottom pipeline into which the output shute can be directed, or coupled. All these various fittings can all be joined together, permanently or temporarily with the same quick clip coupling which is neither male or female and can be used everywhere at either end of the fitting.

These fittings are all made with slow lazy bends, so that fast moving coffee does not impact on flat surfaces. Instead, it gets gently levered round the bend whilst still maintaining its original velocity.



To stop the fast moving grain or coffee without impact, it is necessary to use these cyclone fittings, turning the velocity into a circular motion which drops the coffee out the bottom in a wide spray at nil velocity, and blows the air and dust out the top, where it can be collected separately, and taken on to the husk fuel hopper, which contrary to previous comments, can be a waterproof but not airtight outdoor circular metal silo. Husk and dust make excellent fuel for all kinds of coffee dryers. One large husk fuel silo can feed many air heaters by the same pneumatic system detailed above.

Do note however, that even though we do talk about velocity, the design of pneumatic blowers and equipment really works on pressure and not velocity. The grain industry has worked out the maximum velocity at which grain can be moved without impact damage, even on bends and cyclones. So, a 10hp single stage blower will move X kilos of coffee per hour down a 150mm pipe at Y metres per second because of Z pressure created by the that blower. A two stage blower at 20hp will move say 2 times X kgs of coffee per hour, but only at the same speed/velocity of Y metres/sec. That is twice the weight/density of coffee in the same airstream because there is double the pressure in the tube to push/hold it up. A three stage 50hp blower will blow say 4 x X kgs of coffee, down the same 150mm size tube, and still at the same safe velocity to minimize on impact damage and it can do this because the pressure of the air is 4 times higher in the tube that at say 10hp. However by design, the system cannot convert that pressure into a higher velocity. You will get the picture by looking at the diagrams of the different horsepower blowers. They all have the same size of air intake which actually throttles the big ones down under free flow conditions. If you block the output of a big one it will pump air to much higher pressures, from 0.5 metres of water guage up to 3.5metres. But, if you open the output pipe, instead of turning that extra pressure into a faster speed stream of air, the blower gets rapidly starved of air from the small intake and starts to gargle, and the pressure drops.



Rotary Valve Blower Unit. Venturi Blower Unit.

Data

Direct drive blowers	HP	kW	Min. fuse rating (approx.)	Current consump-tion A	Max. air flow rate m³/h	Max. press mm WG	Total weight kg
TRL 20	2	1.5	10	3.4	1900*)	250	35
TRL 40	4	3	16	6.3	2600*)	350	67
TRL 55	5.5	4	16	8.5	2600*) 1800	650	76
TRL 75	7.5	5.5	20	11.5	3200	650	96
V-belt drive blowers							
TRL 100	10	7.5	25	15.5	1800	950	129
TRL 150	15	11	35	21.5	1800	1300	157
TRL 300	30	22	63	41.5	1800	2300	324
TRL 500	50	37	100	69.5	1800	3500	468

*) Venturi required

A major reason for using a pneumatic transport system is because of its additional capacity to dry coffee in times of overload or emergency. Although it is most certainly not recommended practice, in an emergency several conditioning bins can be filled with wet or half dry parchment and each one blown in succession with a jury rig system at brief intervals, to remove surface moisture and the build up of heat from germination etc. It is thus possible to minimize on mould growth and maintain quality for several days, until the main drying systems can catch up on the overload conditions. As can be seen below, in contrast to the conditioning process, a large blower, working at pneumatic conditions, can supply its own heat into the system. Such a rise in pressure also involves a rise in temperature, and as stated this can be used for drying purposes. Such methods however, do not dry coffee evenly. A drying ‘front’ is created which moves a band of moisture up through the bed of coffee, rewetting and then redrying the parchment as the moisture front moves up through the bin. This

This is tolerable for emergencies but certainly not desirable for general use. The tables illustrated are produced by the

Dania Company in the Netherlands.

Drying

In addition to conveying and ventilating, TRL 75 may be used for drying/conditioning.

The 4-5°C heating of the air provided by the blower reduces the relative humidity and ensures efficient drying/conditioning.

At relative humidities of:	%	50	60	70	80	90	95	100
air at 15°C can dry grain to:	%	12.0	13.5	15.0	16.5	20.0	23.8	27.0
TRL 75 can reduce grain to:	%	10.7	11.5	12.4	13.7	14.3	15.1	16.0

Capacities

Conveying capacities (t/h, cleaned and dried barley)	10 m	20 m	30 m	40 m	50 m	60 m	80 m	100 m	120 m	150 m	200 m
TRL 20 + TF 20	2.5	2.0	1.7	1.4	1.2	1.0	0.7	0.5			
TRL 40 + TF 40	4.3	3.6	3.0	2.6	2.3	2.0	1.6	1.2			
TRL 55/75 + TF 55	4.7	3.9	3.3	2.9	2.5	2.2	1.8	1.4	1.1	0.8	
TRL 55/75 + CA 20	8.7	7.4	6.4	5.6	4.9	4.4	3.5	2.9	2.4	1.8	
TRL 100 + CA 20	16.4	13.8	11.9	10.3	9.1	8.0	6.4	5.2	4.3	3.2	2.0
TRL 150 + CA 20	16.5	15.9	15.3	14.7	13.2	11.7	9.3	7.6	6.2	4.6	2.9
TRL 150 + CA 30	23.9	20.2	17.3	15.0	13.2	11.7	9.3	7.6	6.2	4.6	2.9
TRL 300 + CA 30	26.5	25.5	24.5	23.5	22.5	20.4	16.8	14.1	12.0	9.6	6.9
TRL 300 + CA 40	38.6	33.1	28.8	25.4	22.7	20.4	16.8	14.1	12.0	9.6	6.9
TRL 500 + CA 40	52.9	47.0	42.3	38.3	34.9	32.1	27.4	23.8	21.0	17.6	13.6

1. Lengths include two 90° bends, 4 m vertical pipe + outlet cyclone.
2. For each metre increase in the vertical pipe line the total pipe line is increased by 1.2 m.
3. For each metre by which the vertical pipe line is reduced, the total pipe line length is reduced by 1.2 m.

Each bend in additional to the two bends of the standard pipeline corresponds to one metre of extra horizontal length. This extra length depends on the conveying capacity and, furthermore, the blower size.

The following table shows the extra horizontal length per bend for the different blowers:

Blower	Extra length, m
TRL 20 + TF 20	4.5
TRL 40 + TF 40	5.7
TRL 55/75 + TF 55	5.9
TRL 55/75 + CA 20	7.4
TRL 100	8.9
TRL 150	9.2
TRL 300	10.2
TRL 500	11.3

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