Summary

Drag tube conveying is a rather unknown type of conveying in which the bulk solid material is dragged by disks through a tube circuit. The disks are connected by either a chain or a cable, dependent to the application. In certain scenarios this type of transport is a realistic alternative to the common used pneumatic conveyor. The report describes a comparison of both conveyors in energy consumption, application, costs and environmental issues as the emission of particle matter.

The energy consumption of both conveyors is determined theoretically. Data from practice is collected to confirm the theoretical results. To be able to compare all calculated and found data the transport loss factor (TLF) is introduced. The TLF is a value that represents the energy consumption per ton per meter conveyed. For drag tube conveyors this TLF is 5 to 10 times smaller than for a pneumatic conveyor. It means using a drag tube conveyor instead of a pneumatic conveyor results in a reduction of 80 to 90 % of the energy consumption.

In application the comparison is made on the flexibility of the route and the material flows, the footprint of the installation and the number and complexity of the components.
The first issue is in advantage to pneumatic conveying. With a length of above 300 meters and the possibility to implement many bends pneumatic conveying is far more flexible than drag tube conveying. Only drawback of pneumatic conveying is the large footprint required for components as a compressor and filters. Drag tube conveying only can reach 60 meters, have double tubes (carry side and return side) and have a few bends, but almost all parts are build on the tubes.
For changing material flows drag tube conveying is easier to control. The complexity of this conveyor is sometimes compared to a bicycle chain [34]. Larger flows can be handled by increasing the chain speed and otherwise. Pneumatic conveying is more difficult, because for changing material properties and mass flows the pressure and the air speed have to be changed.

The costs of a drag tube conveyor are even lower than a comparable pneumatic system. In a comparison of both systems to implement in a PTA plant (paragraph 3.2) drag tube conveying has 50 % lower costs than the pneumatic conveyor. The total costs consist of two main parts: the investment costs and the operational costs as energy costs. In the case of the PTA plant the investment as well as the energy consumption are lower for a drag tube conveyor. The high investment is caused by complex components for a pneumatic conveyor as the compressor and the filters.

The range of materials that can be transported is for both types of conveying very wide. With temperatures to 600 degrees, particle diameters to 38 millimetres and the ability of transporting sludgy, explosive and toxic materials the drag tube conveyor can be applied in almost every scenario. Pneumatic conveyors can transport materials until 900 degrees and until 6 millimetres large. Sludgy, explosive and toxic materials can be transported, but the conveyor needs some adjustments.

Dust explosions are caused by the five factors of the dust explosion pentagon (paragraph 4.2.3). Pneumatic conveyors turn out to be most sensitive for this danger. Drag tube conveying has less high scores on the pentagon and the system can be even certified for ATEX 95.

Another advantage of the drag tube conveyor is the emission of particle matter. The bulk solid material is transported in the dense phase, therefore the emission of particle matter is negligible. Pneumatic conveyors however transport in dilute phase, which means the particles are liquefied by a gas. At the outlet of the conveyor the particles have to be separated from the gas flow by a filter installation like a gas cyclone.
High efficiency gas cyclones are able to separate particles with a diameter above 4 µm, but have a lower throughput. A high throughput gas cyclone can be smaller for the same throughput, but have a cut size of about 15 µm. Either for a high flow rate as well as a high efficiency gas cyclone particles with a diameter of less than 4 µm will be emitted. It means $PM_{2.5}$ is not separated, while it is proven $PM_{2.5}$ have larger health effects than PM_{10} (EPA). Adding large expensive filters can solve this problem, but it will increase the costs. Drag tube conveying therefore is a better option in environmental and safety issues.

For conveyor systems with a length of less than 60 meters with a few bends, drag tube conveying is the best option. Either financially, technically, flexibility and in environment issues drag tube conveyor offers many advantages. If the length of the route is (much) longer or contains many bends, then pneumatic conveying could be a better option.