Zenz diagram

The curve in the ***Zenz - diagram*** represents pneumatic conveying as the pressure drop per unit of length as a function of the air flow (or air velocity).

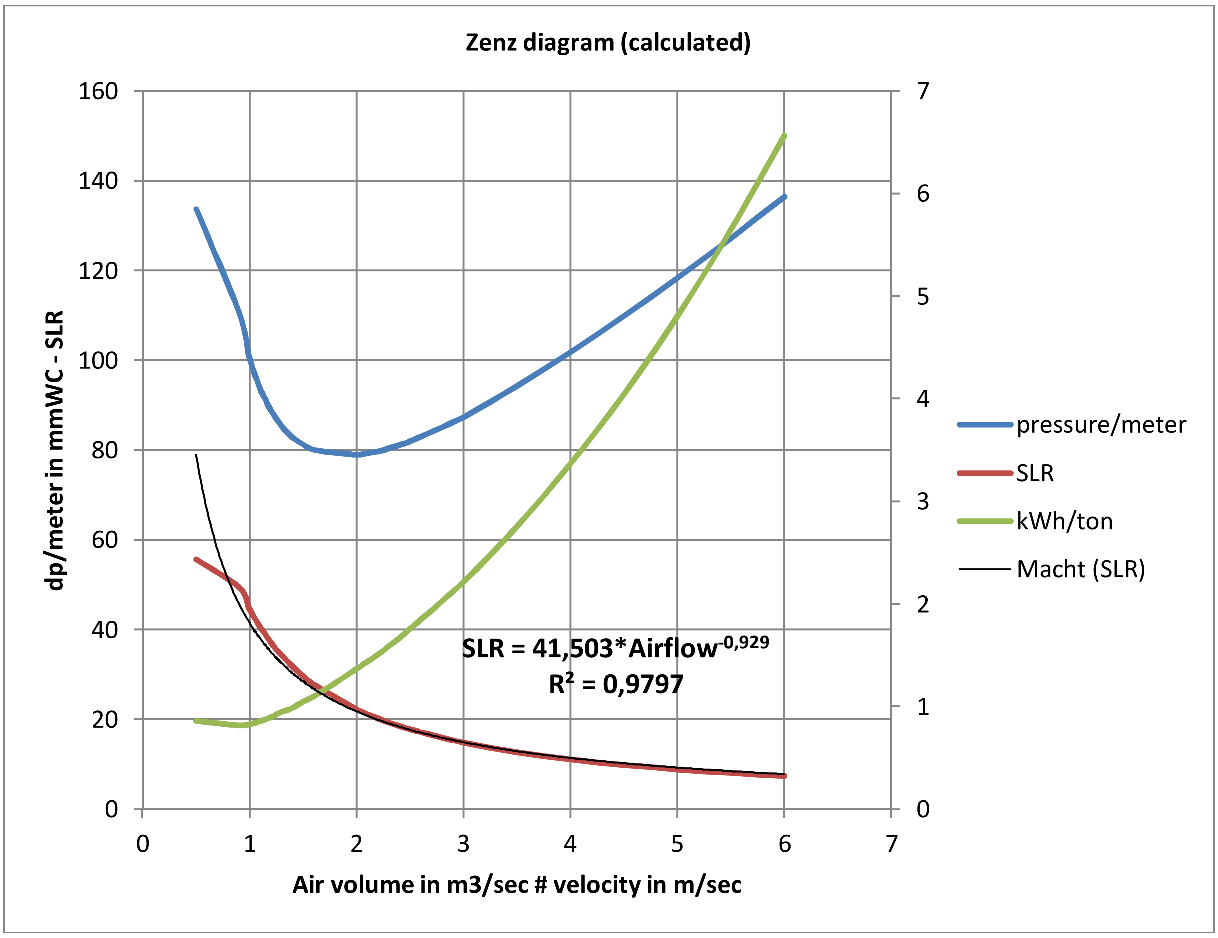
For this curve the solids flow rate and the pipeline are kept constant.

For an existing cement conveying pipe line, this curve is calculated.

The calculation curves are given below:

cement	200		ton/hr	
pipeline	12"		185	meter

Pumpvolume	pressure	pressure / meter	kWh/ton	SLR mu
0,8	24745	134	0,86	55,68
0,9	20475	111	0,82	49,49
1,0	18577	100	0,83	44,54
1,1	17295	93	0,86	40,49
1,13	17048	92	0,87	39,53
1,2	16428	89	0,90	37,12
1,3	15794	85	0,95	34,26
1,4	15333	83	0,99	31,81
1,5	15040	81	1,05	29,69
1,6	14819	80	1,10	27,84
2,0	14612	79	1,37	22,27
2,1	14680	79	1,44	21,21
2,2	14750	80	1,51	20,25
2,3	14875	80	1,59	19,37
2,4	15013	81	1,67	18,56
2,5	15171	82	1,76	17,82
3,0	16175	87	2,22	14,85
3,5	17460	94	2,76	12,73
4,0	18844	102	3,37	11,14
4,5	20340	110	4,05	9,90
5,0	21900	118	4,81	8,91
5,5	23540	127	5,65	8,10
6,0	25260	137	6,57	7,42



From 0.8 m3/sec to 2.0 m3/sec, the pressure drop decreases.
This can be explained as the stronger influence of the decreasing loading ratio, opposed to the weaker influence of the increasing velocity, which would increase the pressure drop per meter.
In addition, the residence time of the particles becomes shorter with increasing velocity and the required pressure drop for keeping the particles in suspension decreases.

From 2.0 m3/sec to 6.0 m3/sec, the pressure drop increases.
This can be explained as the weaker influence of the decreasing loading ratio and the decreasing pressure drop for keeping the particles in suspension, opposed to the stronger influence of the increasing velocity, which increases the pressure drop per meter.

The lowest pressure drop per meter occurs at 2.0 m3/sec.

Left of this point of the lowest pressure drop per meter, the pneumatic conveying is considered: **dense phase** and on the right of this point, the pneumatic conveying is considered: **dilute phase**.

As can be read from the calculation table, the loading ratio (mu) is higher on the left part of the curve than on the right part of the curve.

Regarding the energy consumption per ton conveyed, the lowest value occurs at 0.9 m3/sec.

This can be explained as follows:

The energy consumption per ton is depending on the required power for the air flow.
(solids flow rate is kept constant)
This required power is determined as a function of (pressure * flow).

It appears that the minimum in pressure drop does not coincide with the lowest power demand of the air flow.

As soon as the decreasing airflow (causing lower power demand) is compensated by the increasing pressure drop, the lowest energy consumption per conveyed ton is reached.

The calculation for an air flow of 0.8 m3/sec indicated the beginning of sedimentation in the pipeline, due to the velocities becoming too low.

From this calculation, it can be concluded that a pneumatic conveying design for the lowest possible energy demand, is also a design, using the lowest possible air flow (or velocity).

Dilute phase conveying, as per definition defined, should be avoided.

The lowest possible velocities are also favorable for particle degradation and component's wear.

This example also shows that dense- and dilute phase pneumatic conveying are 2 regions by definition, but belonging to the same pneumatic conveying technology.