ADVANTAGES OF REC BELT OVER WRAPPED BELT DRIVES IN HVAC APPLICATIONS

An extensive study by PIX Transmission has examined the energy saving potential of raw edged cogged (REC) transmission belts over wrapped belts, when operating under similar conditions in HVAC environments.

“In these days of rising energy prices and more stringent regulations, it is important to consider all options for reducing the energy profile of all machinery” reveals Stewart Booth, PIX’s Operations Director. “This is something our customers are asking us for, and was a primary reason for us to carry out the study”.

So PIX, who supply both types of belts, carried out the research, to quantify the comparative energy efficiency of Raw Edge Cogged against traditional Wrapped construction. The results have proved conclusively that REC belts can benefit HVAC customers with potential energy savings of up to 3.8% over wrapped belts.

Any machinery that requires high power transmission coupled with small pulley diameters and high speeds can benefit from REC belts, and ventilation manufacturers are an obvious place to spread the word of their energy saving potential. REC belts with their preformed cogged structure provide extra flexibility and smooth running characteristics, so are ideal for smaller pulleys. They also transmit significantly more torque than their wrapped counterparts.

Efficiency losses in friction belt drives come from two main sources - creep and friction. When belts are installed on pulleys, their static tension is fairly equally distributed between the two ‘strands’ of the belt stretched between the pulleys. When the drive is set in motion, torque transmission is achieved by the installed tension being redistributed, forming a ‘tight side’ and a ‘slack side’, the change in length between tight and slack side strands can only be accommodated by ‘creeping’ of the belt surface over the pulley. The net result of this creep is an effective speed loss at the driven pulley

Friction energy loss is present wherever belt bending and belt ‘entry-to’ and ‘exit-from’ pulley grooves occurs. The textile filled compounds used in wedge belt manufacture are intended primarily to support the load carrying cords of the belts effectively, whilst having good wear properties. A cogged raw edge belt construction minimises belt bending-stiffness, but the materials do have a finite damping energy ratio, which means that hysteresis energy is converted into heat during the constant bending and straightening of the belt in operation.

Hysteresis and friction losses occur as the belt slips across the groove flanks each time the belt enters and leaves the grooves. Raw edge belts have a lesser coefficient of friction, hence suffer less friction loss. The effects of creep, friction energy loss help to promote REC wedge belts over their wrapped counterparts. Wrapped belt drives may also utilise more belts on similar pulley diameters (due to their lesser power capacity), which will further reduce efficiency.

These advantages are well recognised by engineers in “flagship” OEM producers. "This is an important and valuable investigation, and one that endorses what we at Fläkt Woods have accepted for some time now. The REC system has measurable advantages over the wrapped belt - and when we are all looking for ways to demonstrate how to maximise energy efficiency, it serves as an important signpost towards best practice", commented FW …….. manager …….

The investigation also explored the relative advantages of REC over wrapped belt, in terms of belt re-tensioning requirements, by studying the belt tension decay, with time, under controlled conditions.

A new belt drive with proper installation will initially give 95 to 97 % efficiency. Over time energy is lost due to slippage, flex bending of belt over the pulleys etc. Ultimately this loss disseminates as heat, which in turn affects the performance of pulleys, shafts, couplings and associated bearings.

In most of the drives, maintaining optimum belt tension during the course of service by reducing the tension decay itself would lead to a substantial energy saving.

PIX also explored the relative advantages of REC over wrapped belt, in terms of belt re-tensioning requirements, by studying the belt tension decay with time under controlled conditions. Finally the survey analysed and quantified the economic advantage of REC over the wrapped belt.

In all the studies, the belt was mounted over the drive, driven and tensioner pulleys, applied the required tension, by moving the tensioner pulley upward till the specified tension is reached. The belt was allowed to run for one minute without applying the load on the generator so that belt seats properly in to the pulley grooves.

The belt tension was re-adjusted and then the tensioner pulley was locked on its position. The test was started and after reaching the testing speed, the load was gradually applied on the generator within a minute.

Energy consumption

The energy saving study was calculated by applying a 6 kW load on the generator and the cumulative power consumed by the motor with wrapped belt A42 was recorded in the data acquisition system for every 30 seconds, up to 150 hours. Then a REC belt AX 42 was tested under similar condition and the data recorded in the system. The summary of power consumption at 24 hours interval, up to 150 hours, for wrapped as well as REC belts is given in table below.

Energy consumption of belt drive

Time, Hours	Energy consumption, kW		Energy savings, %
	A42	AX42	
1	8.26	7.95	3.75
24	198.82	190.91	3.98
48	395.33	382.28	3.30
72	594.65	574.49	3.39
96	795.74	764.35	3.94
120	991.80	952.92	3.92
144	1192.18	1144.94	3.96
150	1240.05	1194.45	3.68

Study on belt tension decay with time

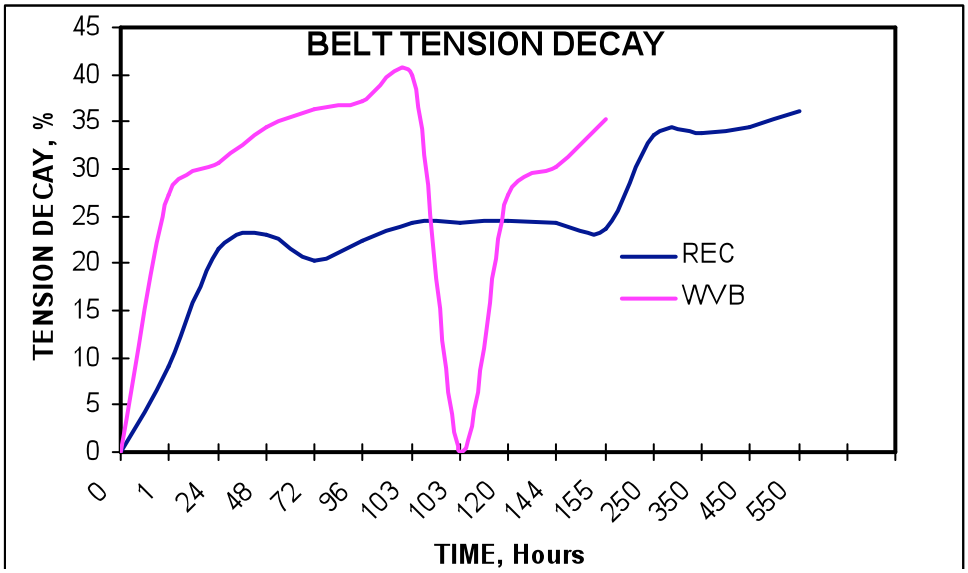
In this study wrapped V belt was mounted on the fixture, applied 50 kg tension and allowed run under 6 kW load in the generator.

The tension decay with time was recorded for every 30 seconds using the data acquisition system. The testing condition is set in such a way that the rig gets tripped whenever the belt slippage exceeds the preset limit of 4% and in such case the belt was allowed to cool down to 30 minutes, belt tension re-adjusted to the original level and then the testing restarted till the belt failed to transmit power.

The tension decay study for REC belt under similar condition as that of wrapped belt was done till the belt failure. The tension decay in terms of percentage with respect to the original for wrapped as well as REC belts is given in figure below.

From the graph the following inferences can be drawn;

A significant portion of tension decay takes place with in 24 hours of starting the testing; nearly 30 % in wrapped and around 20% in the case of REC belt. Such a sharp decay in belt tension could be attributed to the bedding of belts in to the pulley grooves



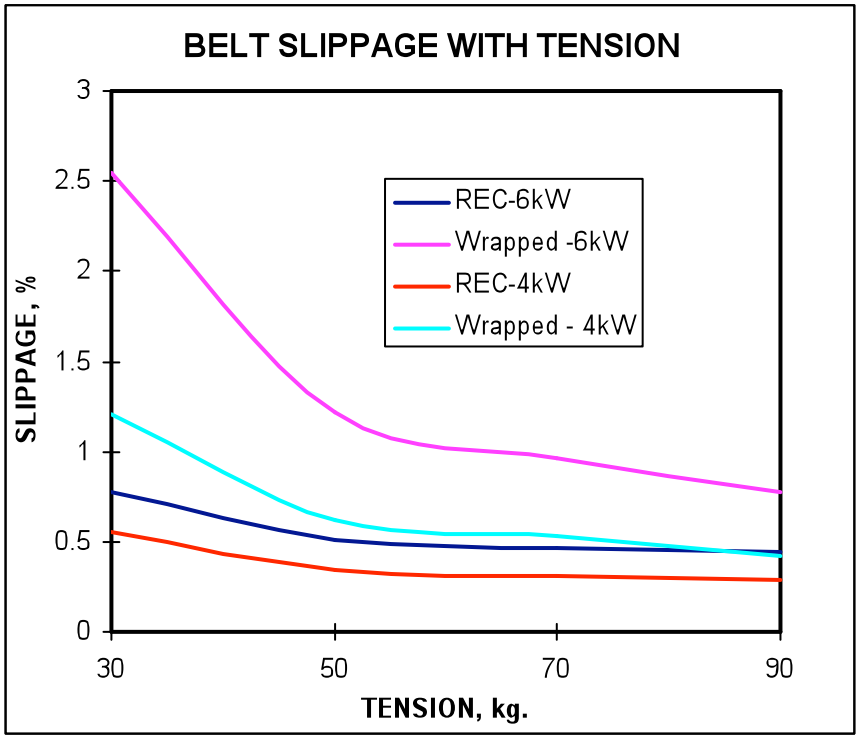
The reversal in the rate of decay is attributed to the heat induced thermal shrinkage of polyester cord. The shrinkage force of polyester cord tries to counter act the tension decay by working against the belt growth.

The performance of REC belt under laboratory testing conditions seems to be almost 3.0 to 3.5 times better than the corresponding wrapped belt.

Belt slippage with tension

The effect of belt tension on slippage of wrapped belt drive in comparison with REC belt has been studied by varying the tension from 30 to 90 kg, at 4 as well as 6 kW loads. In all the tests, the belt after applying the tension was allowed to run and the slippage recorded after 30 minutes only considered for the comparison.

The results are depicted in figure below.



From the graph it is clear that the wrapped v belt experiences higher slippage than the REC belt at any given running condition. The power rating in general is decided based on the maximum power at which the belt slippage does not exceed one percent. Under this laboratory test condition, the power rating of wrapped belt is around 5 kW and that of REC is 8 kW which means that under this running condition the power rating of REC belt is 60% higher than that of wrapped belt.

Conclusion

“The calculations clearly demonstrate that REC belts give energy savings of 3.68 to 3.98%, over the wrapped v belt equivalent, under laboratory testing conditions” summarises Stewart Booth.

“The cost economic analysis based on the field test data indicates an attractive return on investment of REC belt for the HVAC industry. Apart from intangible benefits like less tension on shaft and associated bearings, less down time, and better reliability, with high energy saving potential; the pay back period, on investment of REC belts, can be as short as 3 to 4 weeks, depending on the drive”.