

## CONVEYOR COMPONENTS: Ceramic Lagging on Conveyor Pulleys

C.O. Engineering - Conveyor Components

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Baldor•Dodge offers conveyor pulleys with ceramic lagging, however, you may not be aware the ceramic lagging can be provided as either cold bonded or vulcanized to the steel rim. Vulcanizing is the standard process used to apply rubber lagging to pulleys. Ceramic lagging had been applied by a cold bond method by “cementing” the lagging to the pulley. Baldor•Dodge now can provide ceramic lagging that uses the vulcanizing process that improves the adhesion strength up to 250% over the cold bond applied product. Applications that have had issues with lagging separation due to insufficient bonding strength, when they changed the pulley to a vulcanized ceramic lagged pulley the problem was solved. This technical paper will provide further information concerning the use of ceramic lagging on conveyor pulleys.



The main purposes of using lagging on pulleys is to increase the friction value for transmitting horsepower from the pulley assembly to the belt and to minimize wear of both the pulley and belt. Pulleys are designed based on the belt tensions that are required to transmit the power required to convey materials for that application. Tensions are calculated based on the horsepower requirements for the application and the force required to ensuring no slippage during operation, including full load starting of a stopped

conveyor. These tensions are referred to as the T1, T2, & Te tensions where: Te is the effective tension of the conveyor belt that is required to transmit the horsepower from the driver to the belt. Effective tension is calculated based on the horsepower and speed requirements of the application. T2 is the tension required to ensure no slip and is calculated based on the wrap factor, Cw, which is based on the angle of wrap the belt makes with the pulley and the coefficient of friction. T1 is the total tension or high side tension that is equal to T2 plus Te. T1 tension is the tension on the loaded side of the conveyor in front of the drive pulley. T2 is the low tension on the return side of the conveyor after the drive. Drive pulleys would experience the T1 tension as the belt enters the pulley and T2 as it exits from the pulley.

Since drive pulleys are experiencing a change in tensions as the belt wraps around the pulley there will be inherent slip. The belt elongates as the tension increases due to the stretch of the rubber and cording in the belt. When the tension reduces the belt will contract. Therefore as the conveyor belt enters the pulley it will be slightly elongated and when the belt exits the pulley it

will be slightly shorter, this motion causes slight movement when the load is relieved and the belt shortens. This movement will cause wear. However with the use of rubber lagging, the lagging will flex and compress much like a spring to ensure no slip condition. When the belt exits the pulley the rubber restores to its normal uncompressed condition. This flexing does create a shear load to be applied to the contact surface between the lagging and steel pulley. The lagging is secured to the pulley by special formulated adhesives and the bond strength must be adequate to resist the shear load.

The coefficient of friction between the lagging and the rubber backing of the conveyor belt must be adequate to transmit the torque to the pulley. The higher the frictional value would result in less force required to transmit torque. The use of rubber lagging increases the coefficient of friction by approximately 50% and would reduce the T2 tension and could reduce the resultant size of components required. Lagging also assists in shedding water via grooving; if water is present the grooves will force the water outward from the pulley center. Even with the use of grooved lagging the coefficient of friction will be lower with the presence of water that results in increased tension requirements versus 'dry' applications. For those applications ceramic lagged pulleys have been used to further increase the coefficient of friction. There is no exact value because in theory the actual value would be lower (ie. smooth tile surface on rubber), however ceramic tiles are normally manufactured with raised nubs that create a positive 'mechanical' drive contact that aid in the transmitting torque. With the belt under tension the nubs will imbed in to the belt backing to assist in driving the pulley. This interaction can provide advantages as it can further lower the belt tensions required for the conveyor system and especially for those wet applications. Ceramic tiles are normally imbedded in rubber to provide the relative movement due to the belt transition from T1 to T2 tensions on the drive pulley. It has been observed that when the ratio between T1 & T2 is in the 2 to 3 range then ceramic lagging has proven to be successful. Ratio's greater than 4 then the strength of the ceramic tile and the bond to the rubber is not adequate and failure may occur; failure is due to the tiles cracking, breaking, or coming loose and falling out. There is different theory's regarding failure but it is known that when the ratio increases the lagging thickness must increase to allow the rubber to compress and be successful. If there is not enough rubber thickness then the shear stress may be too great for the rubber, the bonding adhesion may fail, or the tiles push against each other and fracture. In either case the lagging would have failed. It is important to remember that for ceramic lagging any slip is detrimental to the life of the pulley and drive system; damage can occur to both the tiles and backside of the belt.



Due to the mechanics of the rubber during operation it is Baldor•Dodge’s recommendations when ceramic lagging is called for that the proper minimum thickness of rubber is used along with appropriate sized tiles:

Conveyor belts up to 600 PIW – use ¾” square tiles with ½” rubber

Conveyor belts up to 1800 PIW – use 1” square tiles with 5/8” rubber

Conveyor belts over 1800 PIW – 1” square tiles with 1” rubber.

Note: PIW = Conveyor belt load rating in pounds per inch of belt width.

Historically ceramic lagging was only available as a product cold bonded to the pulley rim. The lagging was provided with fully cured rubber strips with the ceramic tiles embedded into it that was adhered to the pulley. The adhesion process is a 2 step part system where the primer is applied to the metal pulley rim and then a cement coating applied to both the rim and rubber lagging. The lagging strips are placed on the pulley with pressure exerted from a roller or mallet to ensure that the strip is 100% in contact with the rim. The strength of this process is dependent on the strength of the adhesive, proper cleaning of the components and with the installer to ensure that no air pockets are present. Pressure is needed to ensure 100% contact and higher the pressure the stronger the bond would be. As ceramic lagging has become more available and technology has evolved, the rubber strips with the ceramic tiles are now furnished on uncured rubber. These strips are placed on a primed pulley with cement and wrapped with nylon tape to apply light pressure to the lagging. The pulley is then vulcanized in an autoclave under control pressure, temperature and time to yield a cured rubber with a high strength bond similar to other vulcanized lagging. The rubber is processed after being installed on the pulley rather than processing strips and ‘cementing’ it to the pulley. The strength of the bond is 250% stronger with the hot vulcanized process over cold bonding. It should be noted that all rubber products need to be vulcanized at some stage of processing to enhance the rubbers’ properties to provide maximum life.

In conclusion the benefits of using Baldor•Dodge ceramic lagging on drive pulleys are:

- a) Improved bonding strength with vulcanization bonding at the manufacturing facility
- b) Increases coefficient of friction values resulting in improved performance minimizing slip in wet environments. Can decrease required T2 tensions optimizing conveyor components that can increase uptime of the conveyor. Can minimize slip during full load starts. Typical values used for coefficient of friction:
 

Ceramic:	Dry: 0.80	Wet: 0.75	Muddy & wet: 0.5
Rubber:	Dry: 0.45	Wet: 0.35	Muddy & wet: 0.3
- c) Improved wear performance with ceramic tiles made from 20% Alumina Oxide that provides excellent wear & abrasion resistance that provides long life capability.

d) Available in both SBR and MSHA (neoprene) rubber