



Lone Star “Premium” Gear Reducer

Brief History of DCA Gears in the USA

The LS Double Circular Arc (DCA) pumping unit gear reducer was introduced to the United States in the late 1970's with pumping units sold under the NPS and HEC brand names. Later, in the mid 1980's, the same LS DCA gear reducer was sold exclusively in the United States by US company, Darco USA, Inc. who sold the “Darco LS” brand pumping unit. The LS DCA gear reducer design was the national standard for all pumping unit manufacturing in China, and it still is today. Darco USA went out of business in 1997 and LS Petrochem Equipment Corp. was formed to sell this same LS pumping unit with the Chinese standard DCA gear reducer. In the early 2000's various Chinese pumping unit factories began to partner with US sales and marketing companies for the sale of their particular brand of pumping units, all still using the Chinese standard LS DCA gear reducer. By the late 2000's marketing reports estimated that greater than 60% of all pumping units sold in the United States were of Chinese origin and using gear reducers with DCA gears. Lone Star Artificial Lift Systems, LLC offers the LS DCA gear reducer as its standard gear reducer on all Lone Star brand pumping units.

LS DCA Features

The DCA gear tooth design is unique in that for every tooth-to-tooth contact there are two points of contact, in contrast to the involute tooth form which only has one point of contact. The two points of tooth-to-tooth contact are actually “areas” or “bands” of contact along the tooth face rather than a line of contact along the tooth face as with an involute tooth. This greater area of tooth contact allows for a more efficient transfer of torque load, resulting in higher pitting resistance torque. The unique DCA tooth design has a wider tooth root than involute creating higher bending strength torque than involute. Because of these features of the DCA design, the DCA tooth is not required to have the same hardness as does the involute tooth design. A consequence of having greater teeth contact areas (or more metal to metal contact) is that the DCA gear reducer operates about 2 to 5 decibels louder than involute gear reducers. Overall, the LS standard DCA gear reducer generally has a torque capacity that is an average 35% greater than its API nameplate rating.

Some US resellers of Chinese-made pumping units have chosen to put involute gears into gear reducer housings that were designed to house DCA gears. This choice is most likely for the marketing reason of being able to apply the API monogram to the gear reducer (*Note: API recognizes only involute gears*), or to have a quieter running gear reducer.

However, for an involute gear reducer to achieve the same torque rating as a DCA gear reducer, the low speed involute gear needs to be a larger diameter than the low speed DCA gear. So the



installation of involute gears into a DCA reducer housing requires the low speed gear to be a smaller diameter in order to fit within the housing. The smaller-diameter low-speed involute gear results in a reduction in the gear reducer's overall torque capacity.

Lone Star ALS “Premium Hybrid” Gear Reducer (US PAT. 8,863,602)

Lone Star ALS is continuously innovating and striving to provide the best products available to the market. In light of the competitive marketplace with numerous competitors selling pumping units with the standard LS design gear reducer, Lone Star has developed the highest strength, highest durability gear reducer made in China. Lone Star calls this the Premium Hybrid or just the “Premium” gear reducer. The Lone Star Premium gear reducer combines the best features of DCA (strength/durability) with the best features of involute (quiet operation) while using better materials and machining processes, resulting in the best pumping unit gear reducer made in the industry.

To achieve quieter operation, Lone Star utilizes involute gears in the high speed reduction. To overcome any potential strength reduction by using involute gears, Lone Star uses high speed gears made of forged steel rather than cast iron or cast steel. Forged steel gears are uncommon in this industry. This involute gear train is then extra-hardened to over HB 400 (over HB100 greater than Lufkin or Weatherford involute gears). The extra-hardened forged involute gears are too hard to be cut with standard gear hobber tooling. Therefore, the gear teeth are formed by high precision grinders which give the high speed gear teeth a polished finished. Grinding pumping unit gears is unheard of in this industry. Grinding gears is the process used to make precision gears such as automobile transmissions. The grinded and polished forged high speed gear teeth are stronger and quieter-running than either the LS standard DCA gear reducer or the fully involute gear reducers made in China (see chart below). The strength of the low speed reduction remains the same as with the standard LS DCA gear reducer, using a forged steel DCA pinion and a nodular cast iron DCA gear.

The Lone Star “Premium” gear reducer is a more expensive gear reducer than Lone Star's standard LS DCA gear reducer. Lone Star offers a “no questions asked” 5-year warranty on the “Premium” gear reducer. US Patent No. 8,863,602 has been awarded for Pump Unit Hybrid Gear Reducer.

Lone Star ALS “Premium Involute” Gear Reducer (API monogrammed)

For Lone Star ALS customers that require their gear reducers be stamped with the API monogram, Lone Star offers the “Premium Involute” gear reducer. The Premium Involute contains the same extra-hardened forged-steel involute set of gears on the high speed reduction as in the Premium Hybrid gear reducer. However, instead of using DCA gears on the low speed gear, the Premium Involute gear reducer has involute teeth. The fully involute tooth gear reducer can be stamped with the API monogram. However because of the involute low speed gear, the overall gear reducer strength is less than the Premium Hybrid gear reducer (see chart below).



Lone Star "Premium" GB Features				
Gear Tooth Design	Hi Speed pinion	Hi Speed gear	Lo Speed pinion	Lo Speed gear
Chinese standard involute	involute	involute	involute	involute
Lone Star "Premium Involute"	involute	involute	involute	involute
LS standard DCA	DCA	DCA	DCA	DCA
Lone Star "Premium Hybrid"	involute	involute	DCA	DCA

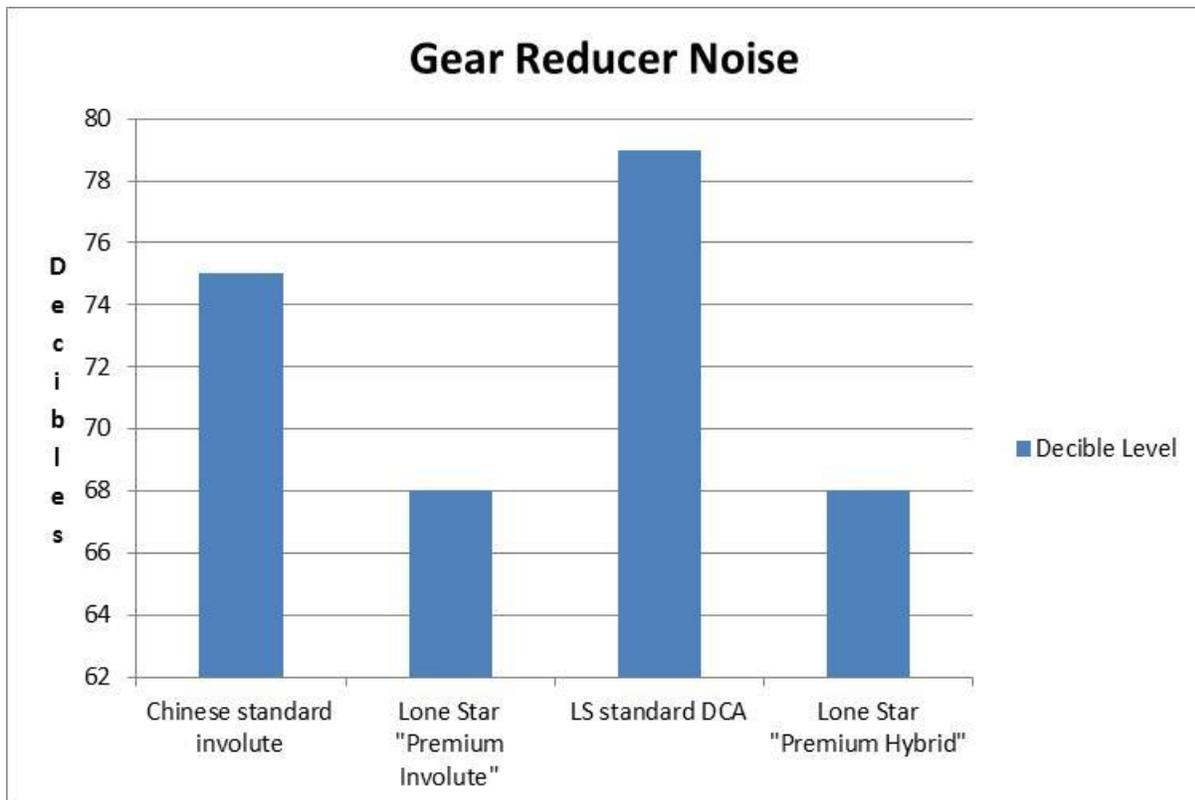
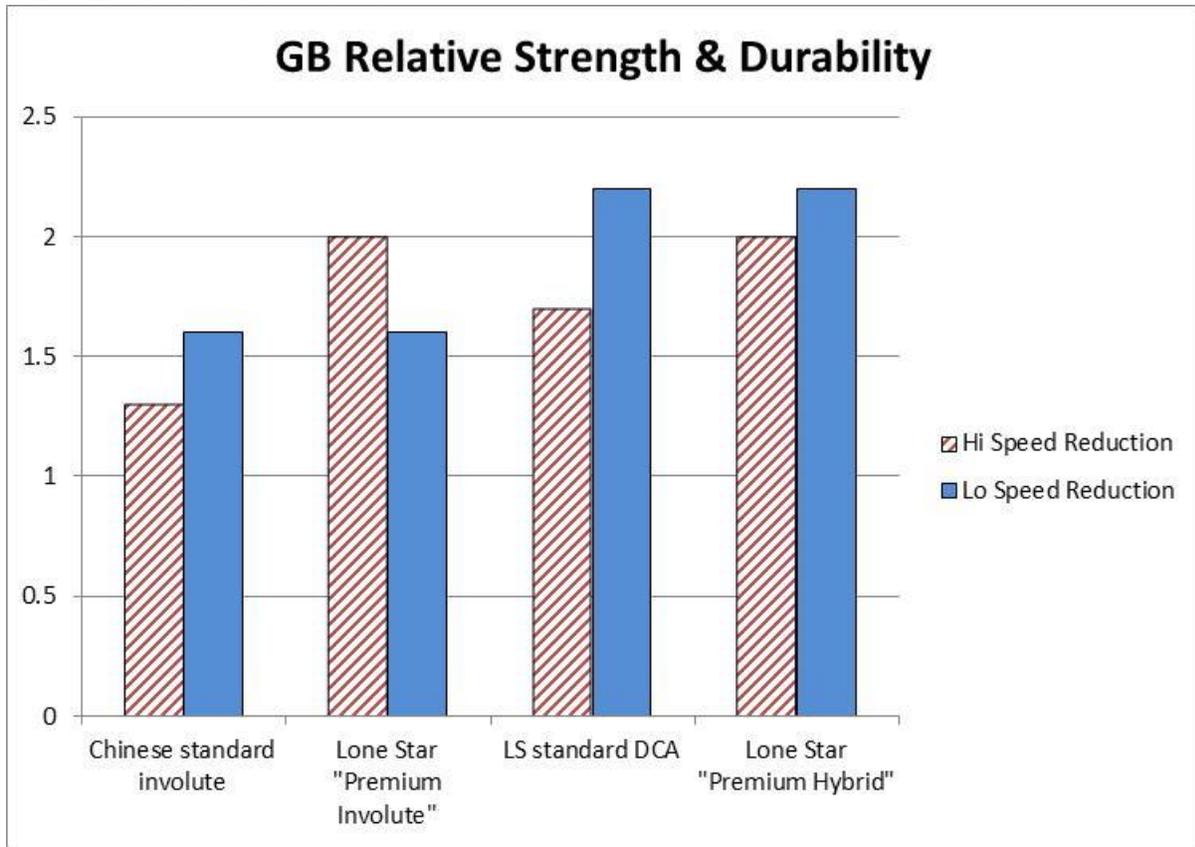
Gear Tooth Process	Hi Speed pinion	Hi Speed gear	Lo Speed pinion	Lo Speed gear
Chinese standard involute	Hobb	Hobb	Hobb	Hobb
Lone Star "Premium Involute"	Grinded	Grinded	Hobb	Hobb
LS standard DCA	Hobb	Hobb	Hobb	Hobb
Lone Star "Premium Hybrid"	Grinded	Grinded	Hobb	Hobb

Gear/Pinion Material	Hi Speed pinion	Hi Speed gear	Lo Speed pinion	Lo Speed gear
Chinese standard involute	forged steel	cast iron	forged steel	cast iron
Lone Star "Premium Involute"	forged steel	forged steel	forged steel	cast iron
LS standard DCA	forged steel	cast steel	forged steel	cast iron
Lone Star "Premium Hybrid"	forged steel	forged steel	forged steel	cast iron

Hardness	Hi Speed pinion	Hi Speed gear	Lo Speed pinion	Lo Speed gear
Chinese standard involute	HB 300-330	HB 260-290	HB 300-330	HB 260-290
Lone Star "Premium Involute"	HB437-464	HB400-437	HB305-335	HB 265-295
LS standard DCA	HB 305-335	HB 265-295	HB 305-335	HB265-295
Lone Star "Premium Hybrid"	HB437-464	HB400-437	HB305-335	HB 265-295

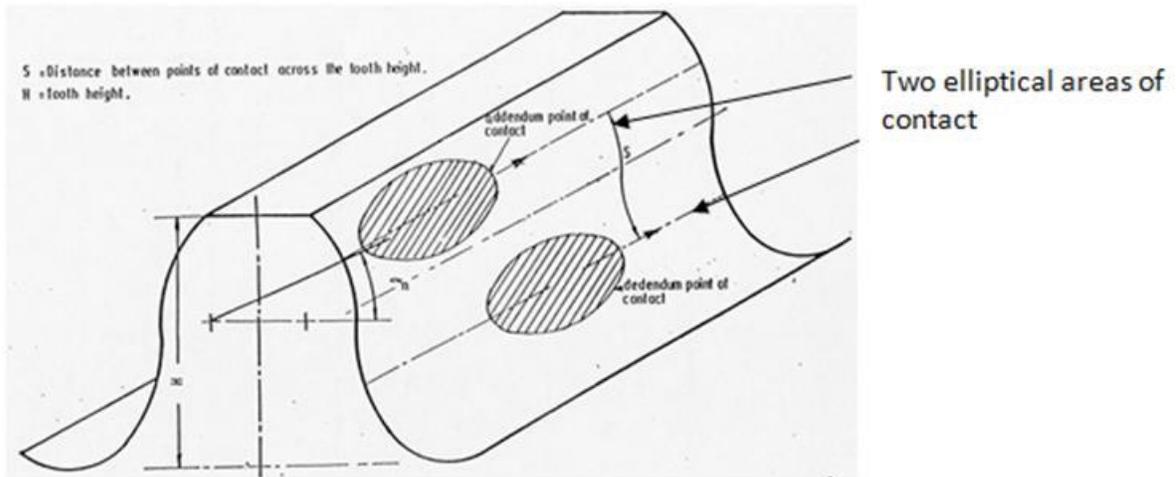
Safety Factor	Hi Speed Reduction	Lo Speed Reduction	Hi Speed pinion	Hi Speed gear	Lo Speed pinion	Lo Speed gear
Chinese standard involute	1.3	1.6	involute	involute	involute	involute
Lone Star "Premium Involute"	2	1.6	grinded involute	grinded involute	involute	involute
LS standard DCA	1.7	2.2	DCA	DCA	DCA	DCA
Lone Star "Premium Hybrid"	2	2.2	grinded involute	grinded involute	DCA	DCA

Decible Level	+/- Decible level	Warranty	Years of Warranty
Chinese standard involute	75	Chinese standard involute	3 yr
Lone Star "Premium Involute"	68	Lone Star "Premium Involute"	5 yr
LS standard DCA	79	LS standard DCA	3 yr
Lone Star "Premium Hybrid"	68	Lone Star "Premium Hybrid"	5 yr

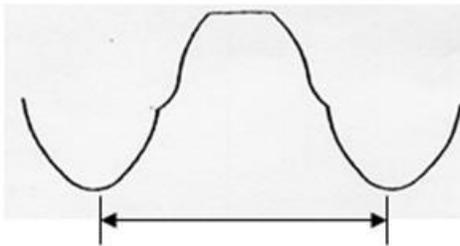


STANDARD DOUBLE CIRCULAR ARC GEARS

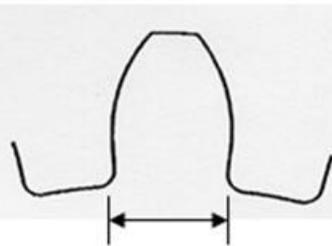
The Double Circular Arc (DCA) gear tooth design is an improvement over the Involute tooth design. A unique feature of DCA gear teeth is their two elliptical areas of contact. These two points of contact allow for a greater area for distribution of load, resulting in lower contact pressure and greater resistance to pitting.



Double Circular Arc



Involute



The wide tooth base results in lower tooth root bending stress than with involute teeth, resulting in greater bending strength torque. These features contribute to the excess torque capacity of DCA gear reducers.