Grease Production, CO_2 emissions a New Relationship!

Andreas Dodos,
Andreas Dodos CLGS, Chem. Engineer

Sustainability is coming into greater focus everyday with organisations setting ambitious targets in order to fulfil internal or regulatory requirements. In the lubricating grease industry, we are seeing more and more products coming on the market that are designed to increase the sustainability of machinery and operations throughout the full spectrum of processes ranging from transportation to food processing and heavy industrial applications. Sustainability criteria can range from the raw material used as for example renewable base stocks to the energy conserving characteristics of novel combinations of base oils, additives and thickening systems. Significant effort is being put into evaluating the performance of lubrication products being placed on the market but what about the actual sustainability of the production process used to manufacture these lubricating greases?

Today, close to 72% of all grease produced globally based on the 2018 Grease Production Survey by the NLGI is based on lithium or lithium complex thickener systems. Although this figure is somewhat reduced compared to say 10 to 15 years ago, in developing regions of the world such as India and China the percentage is even higher. It is worth noting that the technology used to produce lithium-based grease has remained largely unchanged since it was developed in the early 1940s. So, how effective is this 80-year-old process that is adhered to by the majority of grease manufacturers around the world and what can be done to improve the effectiveness of the process utilised?

In order to evaluate the energy efficiency, two ways of manufacturing grease were examined, namely saponification in an open and a pressurised vessel. Additionally, the effect of the base oil used to produce the grease was examined both in terms of the solvency as well as in terms of the overall viscosity of the base oil. The energy used was measured accurately in all production stages. Electrical energy used to pump and mix the materials as well as energy used to homogenise, filter and discharge the product was accounted for. Heating energy was measured based on the consumptions of the actual fuel used to cook the grease.

The work carried out was based on a study previously undertaken by Nynas AB and Stratco Inc. in 2018 and was based on a pilot scale evaluation. In our project we looked at the overall energy consumption of a full-scale production line. Each batch studied was designed to utilise the maximum capacity of the finishing vessels chosen in order to minimise the idle operation of mixers, in particular both in the cooking as well as in the finishing stages.

Considering the scale of this study it was critical to evaluate the performance parameters of the grease produced during each run as these would have to be equivalent to a commercially available product. As it turned out, by optimising the process, there was no sacrifice in the quality of the product. On the contrary, most combinations yielded a final grease that outperformed the industry standard.

The energy was normalised based on a metric ton of grease basis. Allowance for process variations was accounted for, so for example starting conditions such as ambient temperature or going from a hot or cold cooking vessel. An attempt was made to eliminate these variations so that end results could be comparable. Consequently, CO_2 emissions were calculated based on the type of fuel used for heating as well as information on the fuel mix provided form the utility company.

The results surprised all of us. The most commonly manufactured grease – an NLGI grade 2 grease with an ISO VG 100 base oil produced in an open kettle – was the worst performer out of the 8 different combinations considered. Energy consumption as well as CO_2 emissions were more than 30% higher than some of the more efficient options. This was partly due to the actual improvement of the yield that can be obtained by using a more polar, higher viscosity base oil but also the improved heat and mass transfer rates that can be obtained in the pressurised process. In a lot of the cases this 30% energy reduction can mean a 30% reduction in overall production costs and up to 50% reduction in production time. So, an additional benefit that manufacturers can take advantage of is the increase in production capacity and reduction of production costs simply by optimising parameters that relate to the type of base oil used.

Obviously, the reduction of CO_2 emissions is critical with the EU having set targets for a number of industrial applications that need to be met by 2020. The above approach can help lubricants manufacturers benchmark and review one of the more energy intensive operations within the industry which is grease production. Clearly applications with a higher energy consumption will yield the largest reduction in emissions if they are optimised. Furthermore, this approach can give operators a clear picture of the energy distribution within their production units. Today there are utility companies that can guarantee that the energy provided comes form renewable sources. Also, depending on the heating source - electric, hydrocarbon-based fuel (gas or liquid) or the use of alternative/renewable fuels – means that the day we will see a carbon neutral lubricating grease might not be that far away.

Characteristics	**Method**	**TB 01**	**TB 05**	**TB 06**	**TB 08**
Thickener content, [wt.%]	-	**7.2**	**8.9**	**8.2**	**7.1**
Base oil - Type	-	Naph.	Paraf	Paraf	Naph+Paraf
Cooking Vessel - Type	-	Contactor	Atmospheric	Contactor	Contactor
Pen (60), [mm^{-1}]	D 217	264	274	270	266
Dropping point, [°C]	IP 396-02	200	203	201	202
Oil separation, [wt. %]	D 1742	< 0.5	3.61	2.84	2.12
Water wash Out, [wt. %]	D 1264-18	6.3	4.3	2.7	5.9
Diff in Pen. (10^5 str.), [mm^{-1}]	D 217	+ 31	+ 27	+ 35	+ 46
4-Ball Scar wear, [mm]	D2266	0.95	0.82	0.64	0.88
Cu- corrosion, [rating]	D4048	1b	1a	1a	1a
Ox. stability@ 140 °C, [min]	D7575	510	769	1042	762

Table 1. *Grease performance parameters of ISO VG 100 base oil greases evaluated.*

Characteristics	Method	TB 02	TB 03	TB 04	TB 07
Thickener content, [wt.%]	-	4.8	7.5	5.4	7.6
Base Oil - Type	-	**Naph**	**Paraf**	**Naph+Paraf**	**Naph+Para**
Cooking Vessel - Type	-	Contactor	Contactor	Contactor	**Atmospheric**
Pen. (60 st), [mm^{-1}]	D217	269	273	278	273
Dropping Point, [°C]	IP 396-02	205	207	208	204
Oil Separation, [wt. %]	D1742	< 0.5	1.96	2.85	3.74
Water Washout, [wt. %]	D1264-18	4.7	4.7	3.6	4.5
Diff in Pen. (10^5 str.), [mm^{-1}]	D217	+ 46	+ 33	+ 44	+ 31
4-Ball Wear, [mm]	D2266	0.68	0.61	0.65	0.61
Cu- Corrosion, [rating]	D4048	1a	1a	1a	1a
Ox. Stability@ 140 °C, [min]	D7575	750	1082	1099	861
Flow Pressure @ -25 °C, [hPa]	DIN 51805	620	1320	695	N/A

Table 2. *Grease performance parameters of ISO VG 220 base oil greases evaluated.*

Batch ID	Base oil - Type	Viscosity @ 40°C, [mm^2/s]	Thickener content, [wt.%]	Cooking Vessel - Type	Kg eCO_2 emissions/MT
TB 04	N/P	220	5.4	Pressurized	48.62
TB 02	N	220	4.8	Pressurized	53.04
TB 08	N/P	100	7.1	Pressurized	53.38
TB 06	P	100	8.2	Pressurized	53.44
TB 03	P	220	7.5	Pressurized	55.58
TB 01	N	100	7.2	Pressurized	57.81
TB 07	N/P	220	7.6	Open	65.75
TB 05	P	100	8.9	Open	73.62

Table 3. *CO_2 emissions based on the evaluated grease performance parameters.*

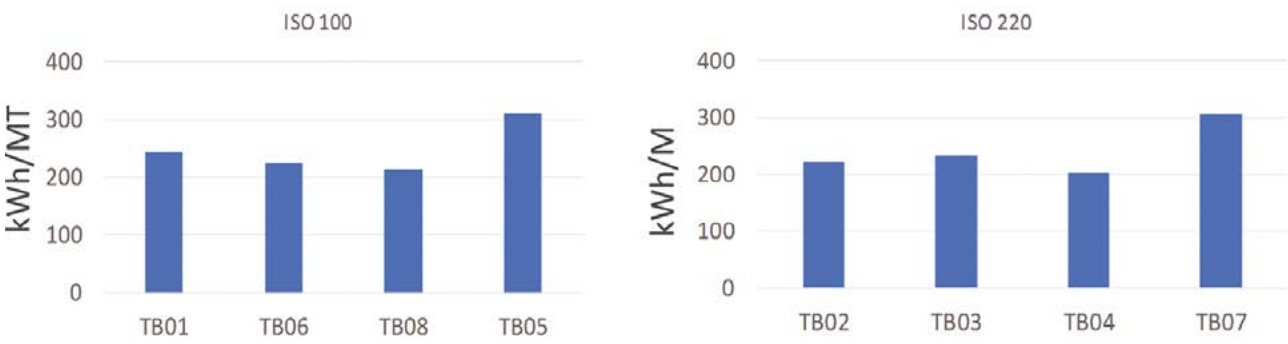

Figure 1. *Overall energy requirement based on base oil viscosity of final product.*

Figure 2. *Electricity requirements for grease batches.*

LINK
www.eldons.gr