SKF @ptitude Exchange

LubeSelect

A bearing lubrication advisory system

Summary
Selecting the correct lubrication for a particular bearing is a crucial step for bearing longevity. SKF engineers have considerable experience and knowledge of greases and oils in association with bearing operation. This knowledge has been encapsulated into an online computer program called LubeSelect, available on http;//www.skf.com. The program allows users to choose from a range of grease and oil types, dependant on the particular operating conditions of the application.

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Introduction

Appropriate lubrication is crucial in all bearing applications. SKF has developed deep knowledge of this topic through fundamental understanding of lubrication, empirical test results, and application experience. SKF's understanding of bearing lubrication has been condensed into a knowledge-based System called LubeSelect. The system, accessible internally since 2000, and externally via Internet since 2002, helps select lubrication by tapping into the combined experience of SKF engineers. As many as 300 SKF engineers use LubeSelect every week. LubeSelect ranks greases and oil types on the basis of their relevance to the application conditions.

Figure 1. LubeSelect is a knowledge-based system for bearing lubricant selection.

In today's knowledge economy, companies need to differentiate themselves with high quality products, and by exploiting their unique knowledge. Knowledge management introduces ways to optimize the creation and flow of knowledge through the company. Amongst the ways to exploit knowledge are expert systems for decision-support. Knowledge can be represented in best practice examples (generalized rules of physical relations with empirical parameters). Different knowledge-based solutions are available depending on the nature and maturity of the knowledge. In line with the dot.com revolution, expert systems can be accessed on the web. Within the SKF Engineering and Research Center, a system was developed for decision support in lubrication. The knowledge resides in fundamental understanding of grease and oil lubrication, empirical test results, and application experience. This knowledge is utilized through LubeSelect, which is available globally via the Internet.

Background

Bearing lubricant selection has traditionally been based on the oil viscosity ratio only. The goal of adequate lubricant viscosity was to build up a thin film of lubricant to prevent direct metallic contact between the rolling elements, raceways and cages. Depending on the various bearing operating conditions, the required oil viscosity can be determined with bearing manufacturers' recommendations with the help of (on-line) catalogues. The ratio between the viscosity of a particular (base) oil at the operating temperature, and the required viscosity needed in the bearing application, is called the viscosity ratio (denoted by a kappa). A rule of thumb is that values between 1 and 2.5 are desired,

but this depends on various other bearing and lubricant factors as well, as discussed below.

A rudimentary expert system, based on viscosity ratio calculations, was developed for grease selection. That system served as a base for recommendations that further differentiated between greases by adding selection criteria other than the viscosity ratio.

A recently developed database, LuBase (www.skf.com), contains product information on a wide range of greases. The system allows for simple searches based on viscosity or consistency. Other bearing suppliers have introduced similar databases and a search facility based on consistency, thickener type, base—oil type and viscosity.

Although the viscosity ratio is still a useful parameter (in particular for oil lubrication), the complexity of grease lubricant performance with special additives, solids, thickeners, base-oil types and other factors is not fully represented. Instead, one must consider all performance characteristics of the grease lubricants light of the bearing application.

Searching on consistency, thickener type, etc. is a step in the right direction.

However, the most important translation from application conditions to desired grease properties is missing. LuBase and other systems operate by allowing users to search through a grease database. LubeSelect, on the other hand, provides lubricant suggestions based on application conditions.

Working principles

LubeSelect can be consulted in two ways:

1. Via application conditions. The conditions describe the bearing environment and are mapped to the performance characteristics of individual greases or oil types. The best “rated" lubricants are ranked first.
2. Via application profiles. For a range of typical bearing applications, grease advice is formulated based on proven-practice examples.

Selection via application conditions

The first step in selecting a lubricant is to get basic information about the bearing application, The user supplies about 30 application parameters. For particular requirements, the user can differentiate importance. Requirements are high rust protection, low noise, biodegradability, etc.

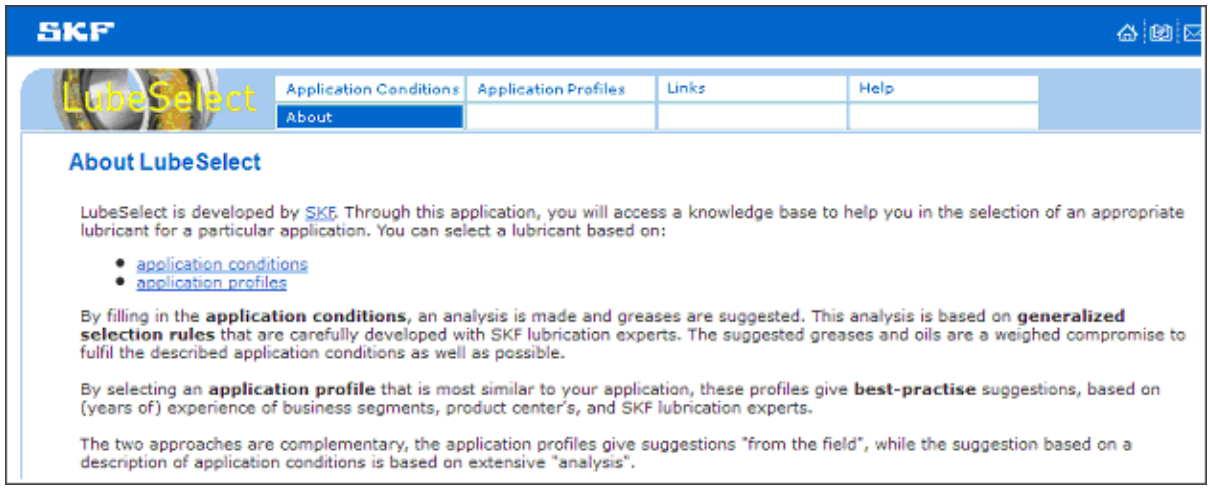

Figure 2. Lubricant selection by application conditions, or application profile

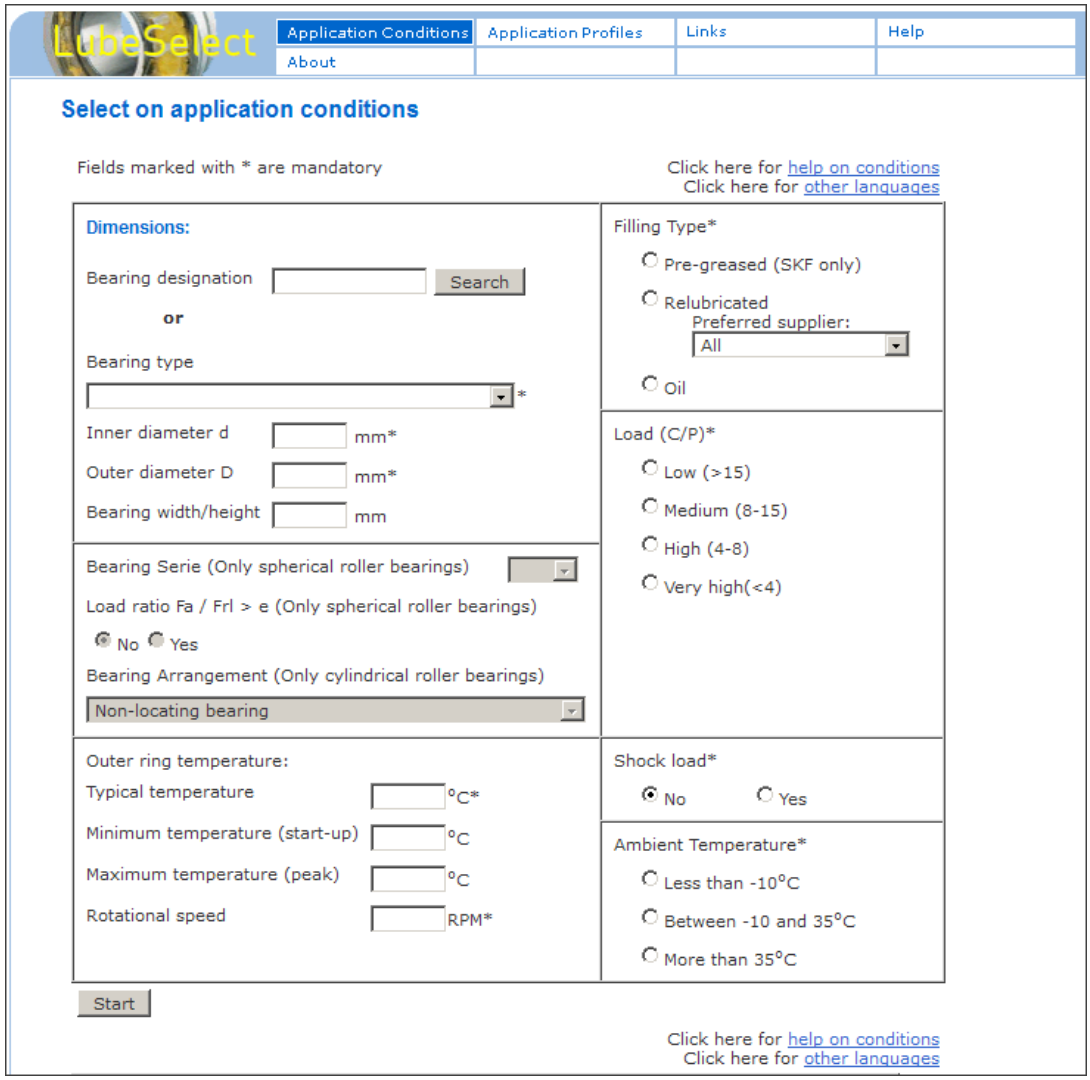

Figure 3. Lubricant Selection via Application Conditions. Other Conditions like Vertical Shaft, Outer Ring Rotation, and Special Requirements like High Rust Protection, Low Noise, Biodegradability, etc., can also be specified.

If application conditions are outside the standard range or special conditions apply, a wider range of greases is considered. These preferred greases are differentiated by their individual performance on bearing-specific criteria. Assuming a range of criteria, specific performance tests are applied (such as a test-rig for noise level measurements, or one of the many lubricant standard tests). After considering the application conditions, the grease`s total score is determined as a fuzzy number between 0 and 1 (no fit : 0, full fit = 1) from the required criteria.

The relevant fuzzy logic calculations are selected from fuzzy decision theory — a computational intelligence methodology. In essence this means that;

- The scoring on different performance criteria is (weighed) averaged.
- The user selects "importance factors" to weigh the criteria, and
- A "zero" score on one criterion cannot compensated by other criteria.

Therefore, the so-called geometric mean operator is chosen by:

$$Score_j = \prod^{n_p} \left(\mu_{i,j}\right)^{\nu_i}, \text{ for i} = 1,\ldots,\mathrm{n_p} \text{ and } j = 1,\ldots,\mathrm{n_g}$$

Where

ν_i = normalized weight factor
$\mu_{i,j}$ = performance of the jth grease for the ith criterion
n_g = number of greases
n_p = number of performance criteria
$Score_j$ = total score for the jth grease

After assessment, the grease lubricants are ranked according to their individual scores, the final scores are expressed in percentages. The grease's rating, including its scoring is the key outcome of selection advice (Figure 4). A range of non-SKF grease lubricants is included as well. This range can be extended by consulting the SKF Engineering and Research Center about the criteria.

The system is further extended by various rules for exception handling and ranking. The recommended grease(s) are accompanied by calculated grease life (or relubrication interval), viscosity ratio, warnings on high start—up (viscous) friction, grease quantity and other grease information.

The oil (type) lubrication advice is mainly based on temperature and viscosity ratio. The result is a list of possible oil types and the desired viscosities (Figure 5). The additional information is provided for the oil types as vvell. With the information, the user can select a particular oil from any supplier.

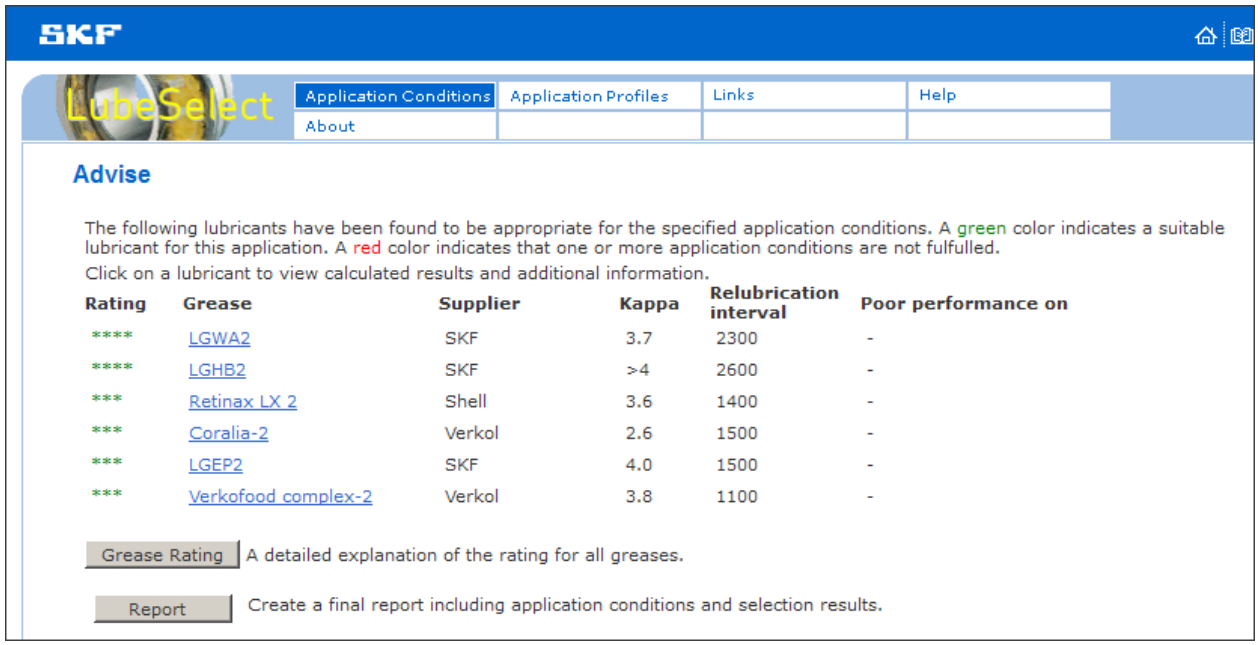

Figure 4. LubeSelect suggests a range of alternative lubricants. Apart from the scoring, vicosity ratio and grease life values are given as well. Individual information and reporting functions are provided by clicking on one of the grease designations.

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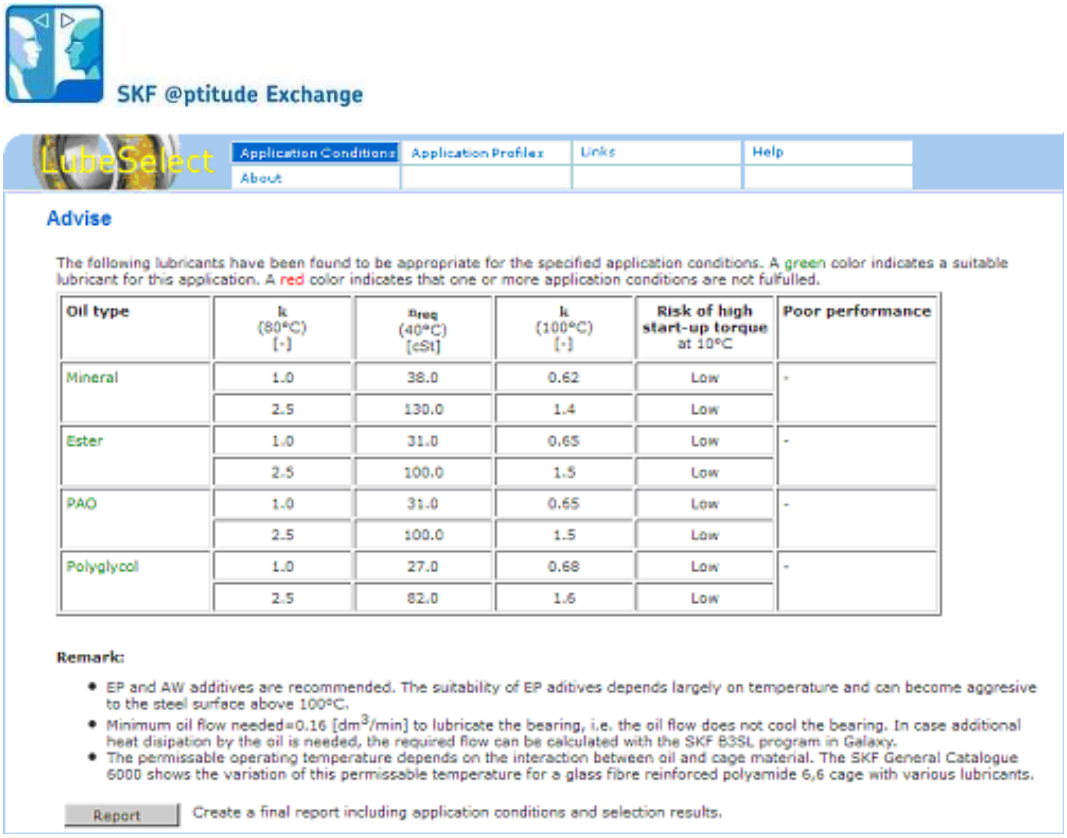

Figure 5. LubeSelect suggests a Range of/ alternative oil types. Depending on the viscosity ratio at operating temperature, the required oil viscosity is provided. Additional input is given concerning the vicosity ratio at peak temperature and the risk of a high start-up torque at minimum temperature.

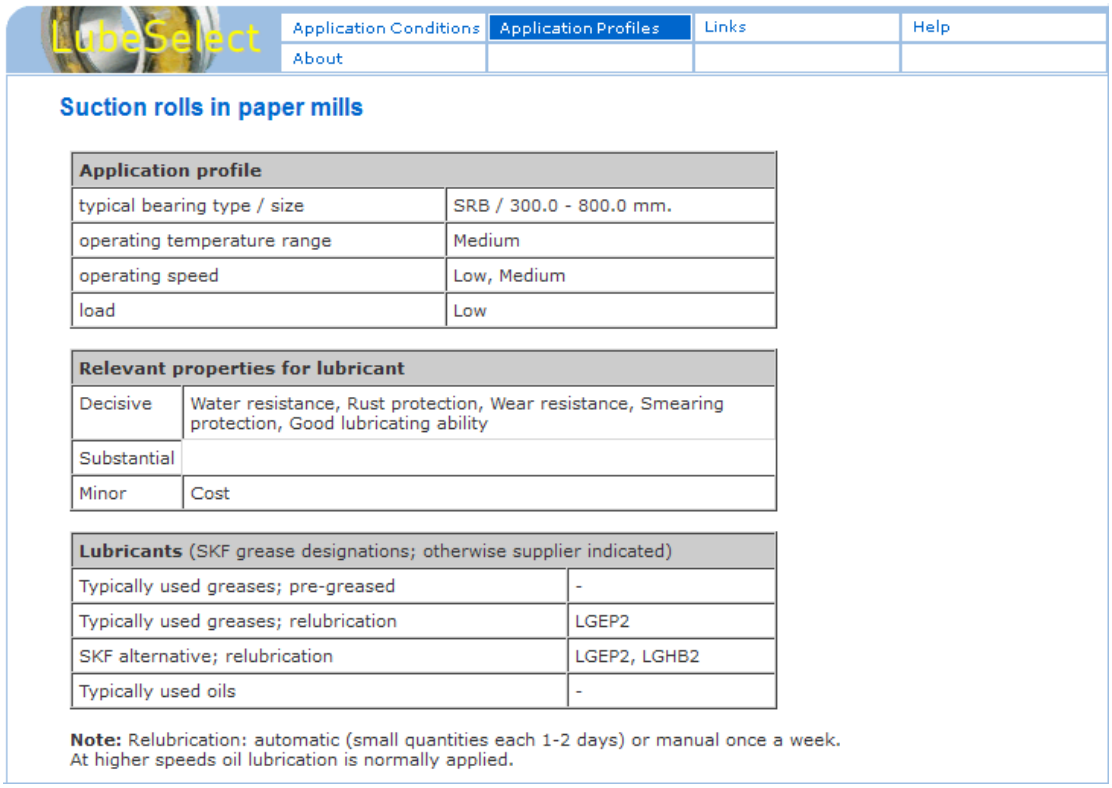

Figure 6. Application Profile Report for Suction Rolls in a Paper Mill.

Selection via application profiles

Another approach in selecting a lubricant is to consider proven—practice application profiles. In cooperation with SKF business segments, lubrication experts, application engineers and about 50 application profiles (for example, pulp and paper applications, Figure 6) are included.

Conclusion

The introduction of a knowledge-based system such as LubeSelect is an effective way to apply key company knowledge to daily decisions, available on http://www.skf.com.

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