Gesellschaft für Tribologie e.V.

Worksheet 9

Lubrication Systems

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1. Introduction – content and purpose of the work sheet

“Good lubrication is necessary for a long life.” – In the early days of technical and later industrial development, this slogan was intended primarily to ensure “abundant” or “sufficient” lubrication. However, today’s highly sophisticated machine and drive-train elements often demand highly precise lubrication with an optimized lubricant to match the operating conditions which prevail during the particular application. For this purpose, not only the lubricant itself must be appropriately selected as a design element which is vital for proper functioning. In many applications, the type of feed system is also decisive for long-term performance and reliability, as well as for avoiding excessive wear and premature failure. Lubrication systems which transport the lubricant to the specified points in a defined quantity and in the appropriate condition are decisive for the performance and economy of technical equipment, machines, and facilities.

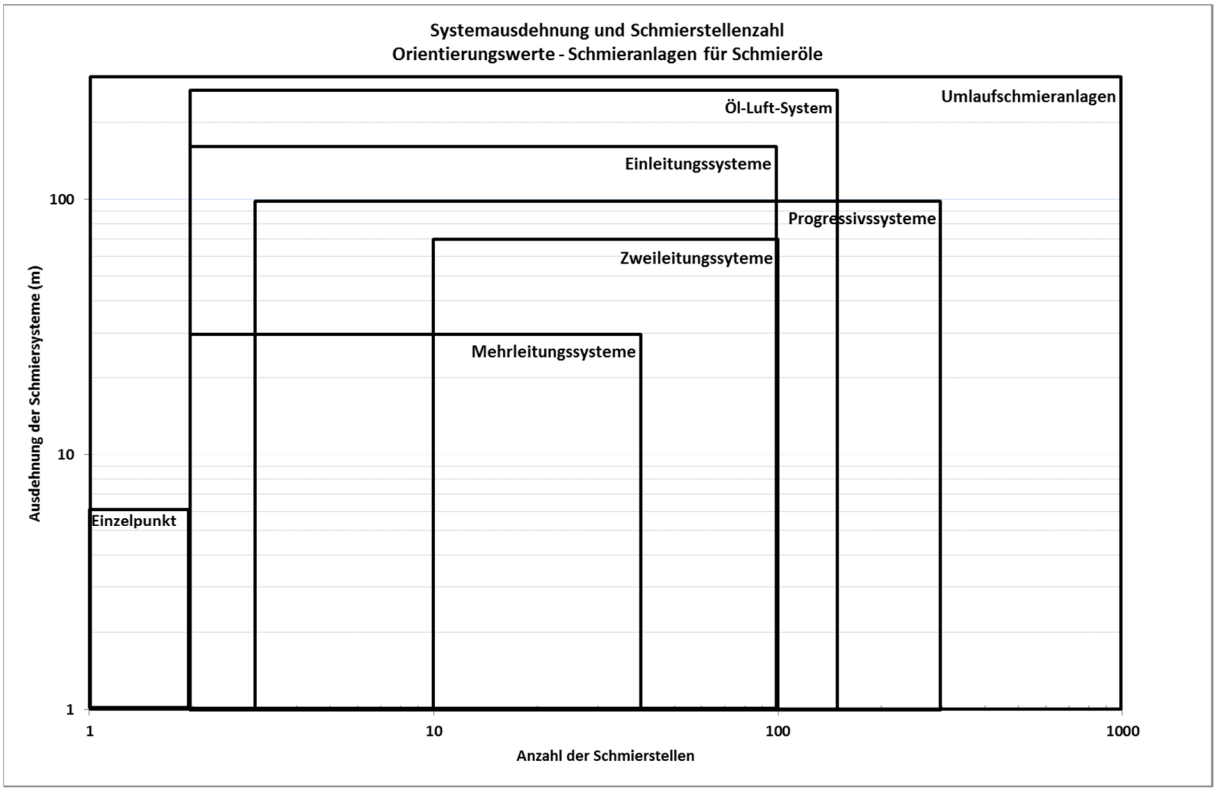
The purpose of the present work sheet is to describe the lubrication systems which are currently in use. The basic functional principles of the respective system and of its components are explained. The performance features of the system concerned and the limitations on its applications are considered on the basis of typical data from practical operations. In this context, the order of presentation corresponds to the fundamental distinction between single-point lubricators and centralized lubrication systems, as well as minimal lubrication systems, which are considered in a separate chapter.

As far as possible, each section pertaining to a particular lubrication system constitutes a complete, self-contained chapter and therefore does not require thorough reading of the entire chapter. The purpose of this work sheet is to provide a comprehensive survey of the various available lubrication systems with a description of possible applications and, wherever appropriate, to include pertinent examples of practical design, as well as associated technical data. It is intended for use by everyone engaged in this field, regardless of educational status or degree of specialization. The limitations on this work sheet are associated with the necessity of adapting a lubrication system to satisfy the conditions which result from the individual application and from the design and construction of the specific system. An absolute prerequisite for these final concretizing steps toward the implementation of a lubrication system is a consideration of the respective manufacturer of the system as well as the actually selected technical components. For reasons of neutrality toward manufacturers, too, individual details must be limited at this point.

2. Systematic classification and selection of lubrication systems and lubricants

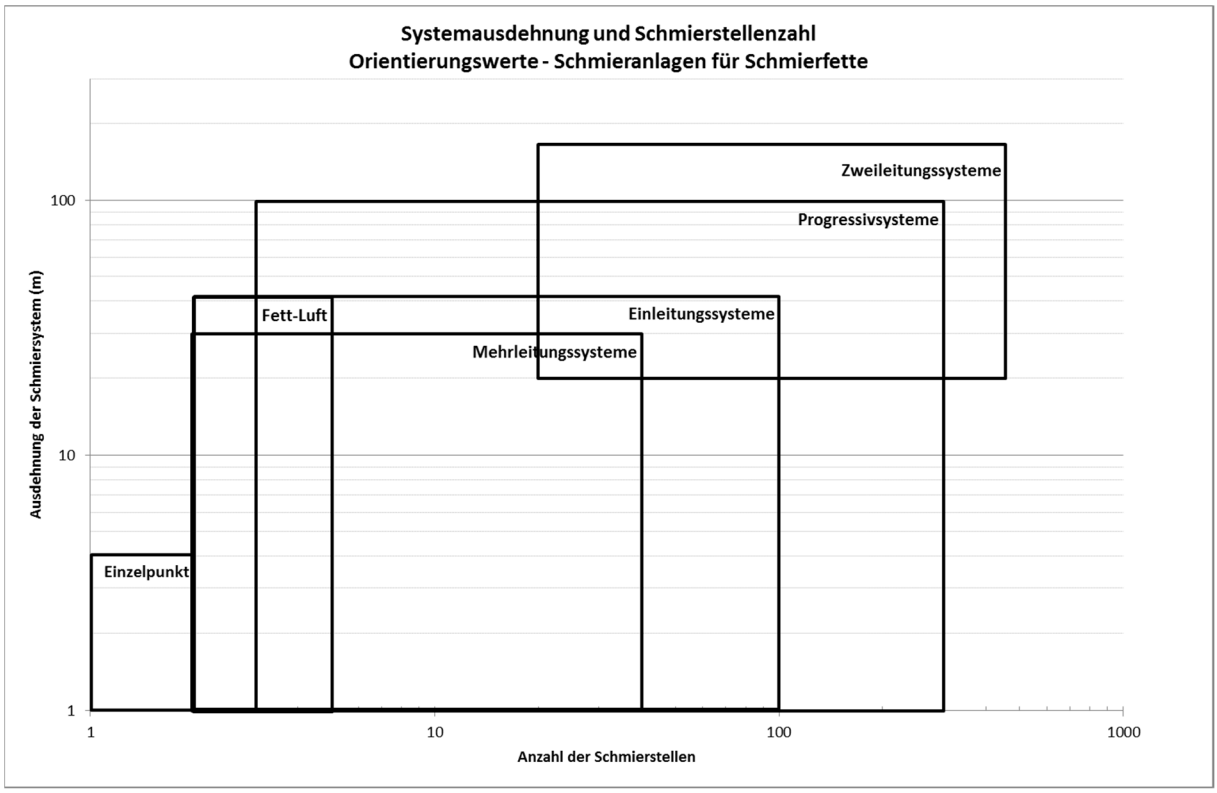
2.1. Selection of lubricants

Guidelines for selection on the basis of spatial extension (distances) of the system and number of points to be lubricated



Ausdehnung der Schmiersysteme	Spatial extension of lubrication system
Systemausdehnung und Schmierstellenzahl	Spatial extension and number of points to be lubricated
Orientierungswerte – Schmieranlagen für Schmieröl	Guidelines – Lubrication systems
Anzahl der Schmierstellen	Number of points to be lubricated
Einzelpunkt	Single-point lubricator
Mehrleitungssystem	Multi-line system
Zweileitungssystem	Dual-line system
Progressivsystem	Progressive system
Einleitungssystem	Single-line system
Öl-Luft-System	Oil-air lubrication system
Umlaufschmieranlagen	Oil-circulation lubrication

Figure 2.1-1: *Spatial extension of the system and number of points to be lubricated in the case of lubrication with oil*



Ausdehnung der Schmiersysteme	Spatial extension of lubrication system
Systemausdehnung und Schmierstellenzahl	Spatial extension and number of points to be lubricated
Orientierungswerte – Schmieranlagen für Schmierfett	Guidelines – Lubrication systems
Anzahl der Schmierstellen	Number of points to be lubricated
Einzelpunkt	Single-point lubricator
Mehrleitungssystem	Multi-line system
Zweileitungssystem	Dual-line system
Progressivsystem	Progressive system
Einleitungssystem	Single-line system
Fett-Luft	Oil-grease lubrication system

Figure 2.1-2: *Spatial extension of the system and number of points to be lubricated in the case of lubrication with grease*

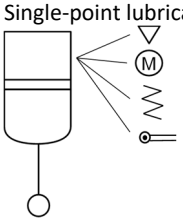
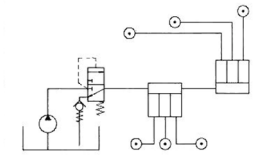
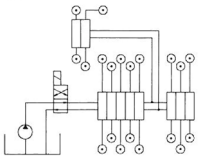
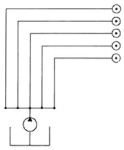
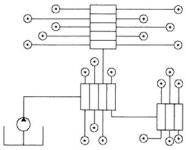
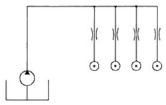
Lubrication systems Symbols in conformance with DIN 2471	**Description of system**	**Typical metering volumes** per lubricating operation	**Typical operating pressure** MPa (bar)	**Number of points to be lubricated**
Single-point lubricators 	One lubricating device per lubricated point; drive unit either electrochemical or electro-mechanical	0.13 – 1.12 cm³	6	1
Single-line systems 	All distributors operate in parallel. Prelubrication distributors: The pump drives the lubricant through the main line to the lubricant distributors. Under pumping pressure, the distributors supply a quantity of lubricant received in advance to the points to be lubricated. The main line is subsequently depressurized. The quantity of lubricant required for the next lubricating operation can thus be received in advance or redistributed within the distributors. Relubrication distributors: The lubricant is transported to the metering chambers of the distributors during the operating period of the application (for example, a heavily loaded plain bearing). The distributors do not supply the metered quantity of lubricant until after depressurization of the main line. (Lubrication after depressurization is designated as relubrication.) Oils and semi-fluid-greases can be transported in this manner.	Prelubrication distributors: Oil: 0.01-1.5 cm³; Relubrication distributors: 0.1-1 cm³	2-4 (20-40) Oil 20-2000 mm²/s; 3-4 (30-40) Semi-fluid grease NLGI 0-000; 10-40 (100-250) Grease NLGI 1-3	2-100
Dual-line systems 	The distributors are connected in parallel. By means of a differential pressure switch, the two main lines are pressurized alternately. In correspondence, lubricant is supplied from the distributor outlets on the respective pressurized side.	0.2-15 cm³	Up to 35 (350)	50-500
Multi-line systems 	Several lubricated points are individually supplied with lubricant. That is, each individual lubricated point is supplied with lubricant directly from the pump outlet through its own individual main line.	Per outlet 0.05-0.5 cm³	5 - 20 (50-200)	1-40
Progressive systems 	The distributors supply lubricant in succession. A pump drives the lubricant through the main line to the distributors. Each distributor outlet is connected to only one single lubricated point or to one further distributor. The distributors are suited for use with greases and oils.	0.025 – 4 cm³ (If oppositely located outlets are combined to serve as single outlet, this outlet supplies twice the quantity, that is, the total quantity.)	2-35 (20-350)	bis 300
Throttle systems 	The following devices can serve as throttles: pipes for larger quantities, screw-in throttles with slit or helix. Screw-in throttles can be combined to form distribution manifolds or mounted directly at the lubrication points. Throttle distributor with adjustable slit	The value depends on the pipe diameter, the pipe length, the throttle distributor, and the viscosity of the oil. 0.1-105 cm³	Up to 2.5 (25)	More than 100

Table 2.1-1: *General survey of selected lubrication systems*

Maximal length of the hydraulic lines	**Monitoring of the function** (typical)	**Lubricants**	**Type of system** 1 Circulation of lubricant 2 Lubrication as consumed a Intermittent b Continuous	**Fields of application** (advantages and disavantages, important details, general remarks)
Oil: 5 m Grease: 3 m	Pressure monitoring, LED indicator, LCD indicator (indication of operational state, empty-state indication, malfunction indication), transparent housing (visual monitoring)	Oils Semi-fluid greases Greases	2a 2a 2a	Various lubricants can be employed, as dictated by the particular application. Planning and later conversion of the devices are easy. The devices are suited only for low operating pressure.
Main line Oil: 40 m Semi-fluid grease: about 20 m	Pressure build-up in the main line: for instance, pressure-actuated switch Important individual lubricated points: for instance, flow-rate monitor	Oils Semi-fluid greases Greases	2a 2a 2a	Lubricated points in small and medium-sized machines, as well as systems in intermittent operation; applications on the vehicle sector; easy planning, conversion of metering units, extension and cut-back of systems Attention to relief times necessary with highly viscous oils, fluid greases, and at low temperatures!
Main line: 20 to 150 m	Pressure build-up in the main line: for instance, pressure-actuated switch Monitoring of distributors by means of cyclic switches	Oils Semi-fluid greases Greases	2a 2a 2a	For medium-sized and larger machines and facilities, especially in smelting plants, rolling mills, and electric power-generating plants; easy planning, metering conversion, and alteration of number of lubricated points; elaborate and
Connecting line to lubricated points: up to about 30 m	Pressure build-up: for instance, pressure-actuated switch, motor-current consumption or similar; lubricant flow rate: for instance, flow monitor	Oils Semi-fluid greases Greases	2a 2b	For smaller machines (machine groups) with lubricated points which are not too far apart; continuous operation with small metering volumes possible
Main line: up to about 100 m; connecting line to lubricated points: up to about 10 m	Monitoring of distributor function: cyclic switches, piston detector	Oils Semi-fluid greases Greases	1a, 1b, 2a, 2b 2a 2a	Grease-lubrication and oil-circulation systems, intermediate transport-volume range; difficult planning, metering conversion, and adaptation or alteration of the number of lubrication-points; closing of superfluous outlets not
Dependent on pressure loss	Flow rate: for instance, flow-rate monitor, pressure	Oils	1b, 2a	Small and large transport volumes possible

	Single-point lubricator	Single-line system	Dual-line system	Multi-line system	Progressive system	Throttle system	Oil-air lubrication system	Micro-metering system	Oil-circulation lubrication system
Machine tools	x	x		x	x	x	x	x	x
Smelting and rolling-mill facilities	x		x	x	x	x	x		x
Foundry machines		x		x	x	x			x
Wood-working machines	x	x	x	x	x				
General air-conditioning facilities	x	x		x	x	x	x		x
Power systems		x		x	x		x		x
Pumps for liquids	x			x	x				
Compressors, pneumatic and vacuum equipment	x	x		x	x	x	x		x
Construction machines and machines for handling building materials		x		x	x				
Machines for the plastic and rubber industries	x	x		x	x	x			
Mining machines	x	x	x	x	x				x
Agricultural machines		x		x	x	x			
Machines for the food and packaging industries	x	x		x	x	x	x		x
Machines and apparatus for the processing industries	x	x		x	x			x	
Conveyor and transport machinery	x	x	x	x	x				
Printing presses and machines for the paper industry	x	x	x	x	x	x	x		x
Textile machines (not including driers)		x		x	x	x			x
Machines for the clothing and leather industries	x	x		x	x	x			x
Valves and fittings	x	x		x					
Elevators and escalators	x	x		x	x				
Drive trains	x	x	x	x	x	x	x	x	x
Motors and systems		x		x					x
Assembly, handling, industrial robots	x	x		x	x			x	
Equipment for the production of semiconductors and flat display units		x		x	x			x	

Table 2.1-2: Applications of lubrication systems in various fields of industry