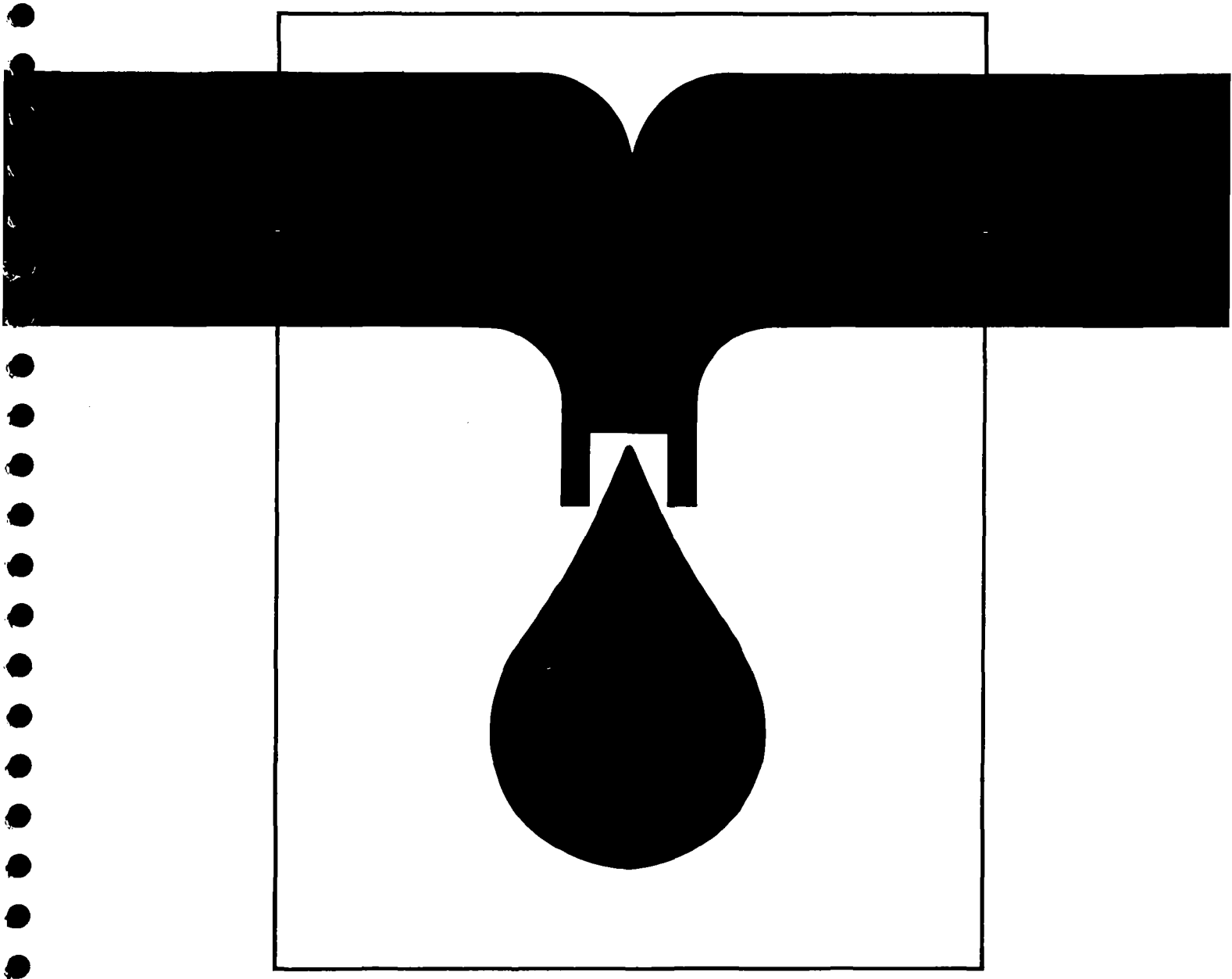
TRAINING MODULES
FOR
WATERWORKS PERSONNEL



Special Skills

3.3 f

Handling, maintenance and repair
of blowers and compressors

Foreword

Even the greatest optimists are no longer sure that the goals of the UN "International Drinking Water Supply and Sanitation Decade", set in 1977 in Mar del Plata, can be achieved by 1990. High population growth in the Third World combined with stagnating financial and personnel resources have led to modifications to the strategies in cooperation with developing countries. A reorientation process has commenced which can be characterized by the following catchwords:

- use of appropriate, simple and – if possible – low-cost technologies,
- lowering of excessively high water-supply and disposal standards,
- priority to optimal operation and maintenance, rather than new investments,
- emphasis on institution-building and human resources development.

Our training modules are an effort to translate the last two strategies into practice. Experience has shown that a standardized training system for waterworks personnel in developing countries does not meet our partners' varying individual needs. But to prepare specific documents for each new project or compile them anew from existing materials on hand cannot be justified from the economic viewpoint. We have therefore opted for a flexible system of training modules which can be combined to suit the situation and needs of the target group in each case, and thus put existing personnel in a position to optimally maintain and operate the plant.

The modules will primarily be used as guidelines and basic training aids by GTZ staff and GTZ consultants in institution-building and operation and maintenance projects. In the medium term, however, they could be used by local instructors, trainers, plant managers and operating personnel in their daily work, as check lists and working instructions.

45 modules are presently available, each covering subject-specific knowledge and skills required in individual areas of waterworks operations, preventive maintenance and repair. Different combinations of modules will be required for classroom work, exercises, and practical application, to suit in each case the type of project, size of plant and the previous qualifications and practical experience of potential users.

Practical day-to-day use will of course generate hints on how to supplement or modify the texts. In other words: this edition is by no means a finalized version. We hope to receive your critical comments on the modules so that they can be optimized over the course of time.

Our grateful thanks are due to

Prof. Dr.-Ing. H.P. Haug
and
Ing.-Grad. H. Hack

for their committed coordination work and also to the following co-authors for preparing the modules:

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It is my sincere wish that these training modules will be put to successful use and will thus support world-wide efforts in improving water supply and raising living standards.

Dr. Ing. Klaus Erbel
Head of Division
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Water Resources Development

Eschborn, May 1987

Title: Handling, maintenance and repair of blowers and compressors

Table of contents:

1. Liquid-ring gas pump (Fig. 2, Module 2.3.f)

Maintenance and repair

Liquid-ring gas pumps to be used in waterworks must have axial face seals. Apart from lubrication of the rolling bearings after every 3000 - 5000 hours of operation, pumps of this type require no maintenance.

2. Rotary blowers

Setting-up

Preparation

Before the blower is located on its foundation, any components coated with slushing oil must be cleaned. The blower connections remain sealed until the piping is finally attached.

Couplings and pulleys

Any rust-inhibiting paint must be removed from the shaft journals before the couplings or pulleys are fitted. Fitting should be carried out using suitable devices, which are to be applied at the centre hole of the shaft journal.

Fitting and later disassembly are facilitated if the shaft journal is coated with oil.

A hammer should under no circumstances be used to fit couplings and pulleys.

Foundation

Rotary blowers must be set up on level, vibration-free foundations. If they have to be set up on floors or steel constructions which are liable to vibrate, it is recommended to place them on flexible mountings which can attenuate structure-borne noise; the blower and drive motor are to be mounted on a single baseframe.

Alignment

The blower unit is placed on the foundation and brought into a precisely horizontal position with the aid of steel shims. The spirit level should be placed on machined surfaces or on the shaft journal.

Maximum permissible deviation from the horizontal: 0.2 mm for 1 m of length. The steel shims are set back somewhat behind the baseframe and are cast into place with it. If the blower and drive motor are set up without a common baseplate, the blower must be higher up in order to ensure that realignment is possible without difficulty.

Anchor bolts

The anchor bolts are to be cast into place following alignment and tightened once the casting compound has set. It must be possible to rotate the blower easily by hand. If there is any resistance, this indicates that the baseplate or housing is distorted, or that there are foreign bodies in the cylinder.

Piping

The pipes are to be carefully cleaned and any foreign bodies (e.g. welding beads) removed. Start-up filters in the inlet lines have proven useful in trial runs (see "Commissioning"). The pipes must be connected such that they are free of stresses. Before tightening, a check must be made using feeler gauges to ensure that the blower and pipe flanges are parallel. The distance between the flanges should correspond to the thickness of the seal. Once the flange connections have been securely tightened, the blower is to be rotated by hand and a check made to ensure that it runs easily.

The weight of the pipes and silencers must be absorbed. Flexible pipe connections (rubber sockets or corrugated pipes) are to be located after the silencers, as seen from the blower. If, in cases where gases are being handled, there is a possibility of condensation, condensate drain plugs are to be provided at the lowest points of the pipes and silencers.

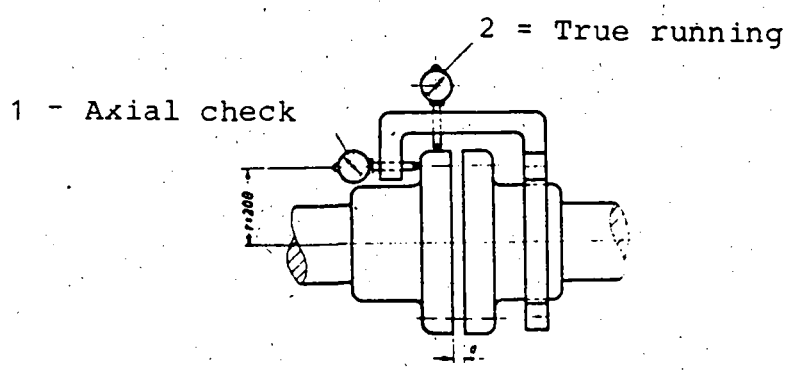


Fig. 1: Realignment of couplings

Realignment

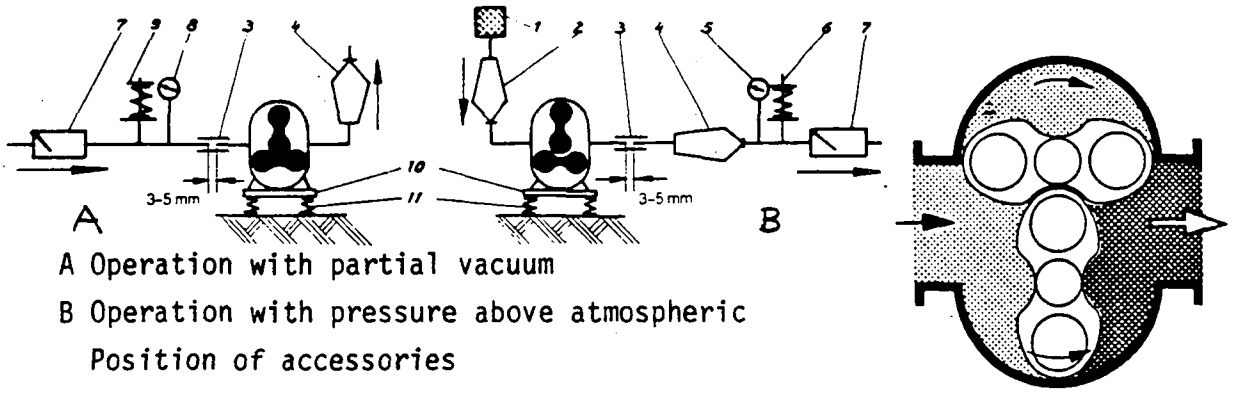
Direct coupling

The blower shaft is to be regarded as a fixed reference point for alignment work. The drive motor installed at a lower level is to be realigned with the aid of sheet metal shims, which must extend over the full surface area of the mountings.

The specified distance between the two halves of the coupling must be observed. In the case of flexible couplings this distance is 3 - 8 mm; for special couplings the special installation specifications must be observed.

The precise alignment of the couplings is to be checked using dial gauges. Couplings in which the flange diameters are identical can also be checked using a ruler and feeler gauges.

For alignment using dial gauges, the measuring set-up shown in Fig. 1 should be used. The two dial gauges are secured to one half of the coupling using an appropriate device. The pins press against the flange on the other half of the coupling. Both shafts are to be rotated simultaneously and the maximum dial gauge deflections noted.



A Operation with partial vacuum

B Operation with pressure above atmospheric

Position of accessories

1 Inlet filter
2 Inlet silencer
3 Rubber socket
4 Discharge silencer
5 Pressure gauge
6 Discharge valve
7 Non-return valve
8 Vacuum gauge
9 Inlet valve
1o Baseplate
11 Flexible mountings

Fig. 2: Position of accessories

The diagrams in Fig. 2 show how the overall set-up is arranged if the blower has a flexible mounting. No baseplate is needed if the blower is set up on the foundation without flexible mountings; the flexible connection for the inlet and discharge pipes, however, is necessary in all cases. The arrangement of the fitting varies depending on application.

Commissioning

The specifications with regard to setting-up and maintenance must be observed in detail.

Trial running of drive motor

During a trial run the motor must not be connected to the blower. The motor must be checked with regard to direction of rotation and quiet running.

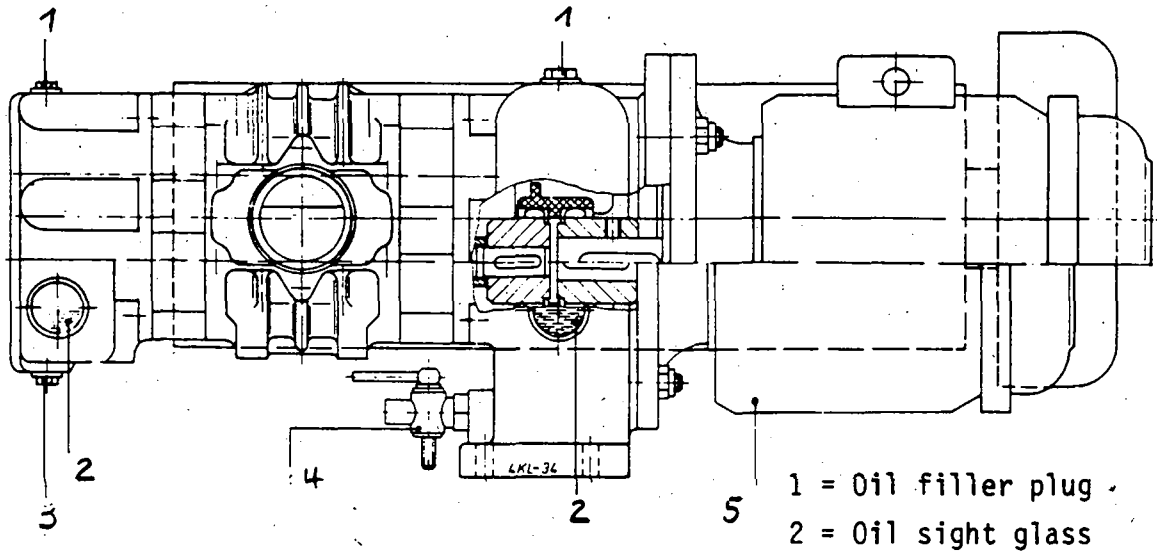
Preparing the blower for trial running

Rotate blower by hand in order to check ease of movement. If there is resistance, check the blower to determine if it has been set up such that it is free of stresses. To do this, loosen flange connections and - if necessary - foundation bolts. The delivery chamber should be checked for foreign bodies.

In closed piping system it is a good idea to install start-up filters on the inlet side to protect the blower against foreign bodies.

Pour in lubricating oil as detailed in the maintenance specifications. If the blower is driven via an intermediate gear unit, check the pillow blocks to ensure that they have an adequate grease filling. If necessary, add suitable rolling-bearing grease.

Check to see that all safety features are fitted as specified (in particular, direction of flow of non-return valves, regulators and other valves).



1 = Oil filler plug
2 = Oil sight glass
3 = Oil drain plug
4 = Oil drain cock
5 = Three-phase motor

Fig. 3: Oil filler points and sight glasses on a rotary blower

Open gate valves on inlet and discharge sides. On account of the forced delivery the blower must not be operated with the gate valves closed. The blower is protected against incorrect operation by discharge or inlet safety valves.
Start up any sealing-gas, coolant or lubricating-oil systems provided.
Check piping for blind flanges.

Trial running of blower

During trial running, the maximum operating pressure given on the rating plate must not be exceeded.
The following should be observed: Quiet running of blower and coupling, housing temperature, shaft seals, free discharge upon shutdown, ease of rotation by hand after trial running.
In normal operation, rotary blowers require exceptionally little maintenance. The rotating pistons do not come into contact with each other or with any other parts and require no lubrication.

Maintenance

Seals

In the various different type series, the delivery chambers are separated from the bearing chambers by piston-ring seals and condensate ducts. If air is being handled, the condensate holes are opened; this means that a small air flow can exit and flush the condensate ducts.
The drive shaft has a radial seal.

Lubrication

Rotary blowers normally have splash lubrication. The oil level should be checked regularly; the correct level, with the blower at a standstill, is in the middle of the sight glass. If the oil level is too high, a rise in temperature in the gear chamber and leakage of oil into the delivery chamber are likely.

Oil change

Following initial commissioning, the oil is to be changed after around 100 hours of operation. If the unit is used in day and night operation, the oil should then be changed after around six months, otherwise after one year, assuming that the media handled are uncontaminated. In the event of unfavourable operating conditions, the oil should be changed at shorter intervals.

Additional specifications apply with regard to units having oil circuit lubrication.

Recommended lubricating oil

Good-qualitiy brand oils which are chemically neutral and stable and exhibit a high degree of resistance to ageing are to be used for lubrication. Motor-vehicle engine oils of viscosity class SAE 30 (normal operation) or SAE 40 (higher temperatures) can be used.

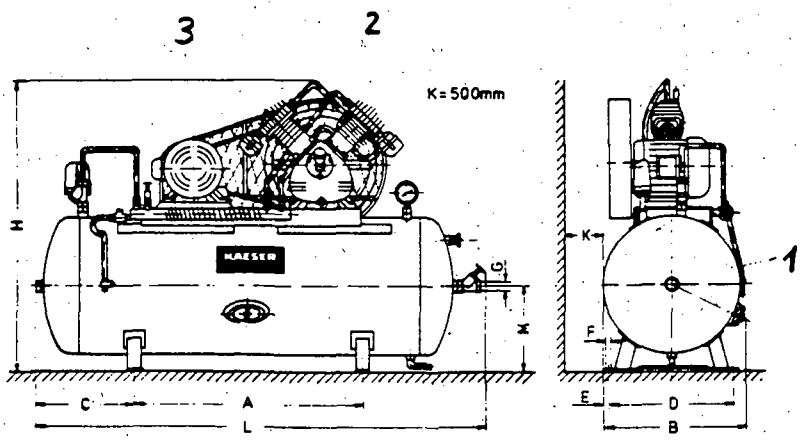
Cleaning the blower

As the rotating pistons do not come into contact with each other or with other parts, the clearance between the pistons and the blower housing means that dust-containing media can also be handled to a limited extent.

The delivery chamber can be inspected and - if necessary - cleaned following removal of the pipe. Adhering deposits are to be removed - depending on their nature - using a scraper or a suitable solvent, benzine or kerosine. The upper cylinder parts of the blower must be refitted with particular care following cleaning. Before the screws are tightened, the taper pins must be inserted; after reassembly the blower must be checked to ensure that it is running properly and a check made on the clearance between the rotating pistons and the blower housing and side plates.

The lubricating oil must be changed following thorough cleaning.

3. Positive-displacement compressors



1 One-way surge tank
2 Positive-displacement compressor
3 Drive unit: Electric motor

Fig. 4: Compact compressor unit

Notes on installation

Compressor systems must never be enclosed by hoods which impair cooling.

Positive-displacement compressors cannot start up against the full operating pressure. There must be a vent valve in the discharge line between the compressor and the non-return valve. The vent valve is generally already fitted if a complete compressor unit is purchased.

Lubrication

All compressor systems and units are supplied with the oil already inside. Before the electrical connections are made, the oil level must be checked and the compressor filled if necessary with an oil as specified in the lubricating-oil chart. Even short trial runs - to determine the direction of rotation - with no oil or too little oil in the compressor can cause damage.

The oil level must be checked from time to time by removing the red dipstick with the compressor at a standstill. The oil level must not be lower than the lowest mark on the dipstick. The oil must be topped up at the latest when the oil level reaches the lower third of the dipstick.

Oil change

The first oil change should be carried out after around 300 - 500 hours of operation, with the oil subsequently being changed after approximately every 1500 - 2000 hours of operation.

Maintenance and elimination of faults

Compressor systems and units are to be shut down if they are to be moved or if maintenance, cleaning and repair work is to be performed. Automatic systems are to be rendered dead or disconnected from the mains before such work is performed on account of the increased risk of accidents. Any belt and fan protective grilles which are temporarily removed must be replaced before the unit is started up again.

Incorrect performing of work on compressors, compressed-air reservoirs and fittings which are under pressure is extremely dangerous.

Before assembly, maintenance, cleaning and repair work, as well as before the removal and installation of individual components, vessels, fittings and screw connections, the compressed-air system must be depressurized or shut off from the vessel or line pressure.

Welding work on compressed-air reservoirs and pressure vessels must be performed only by certified welders. Re-acceptance and hydrostatic tests must be carried out following welding work on such reservoirs and vessels.

4. Diaphragm compressors

Maintenance and repair
Diaphragm compressors are maintenance-free.

If, after having been in operation for a lengthy period, the diaphragm is found to be irreparably worn or damaged, it can be easily replaced.
Note on installation
Diaphragm compressors cannot start up against the full operating pressure. In order to facilitate start-up, a non-return valve must be provided between the vessel and the compressor; the discharge line between this valve and the compressor must also be pressure-relieved when the compressor is switched off. This enables the unit to start up against the pressure-relieved discharge line.

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The government-owned GTZ operates in the field of Technical Cooperation. Some 4,500 German experts are working together with partners from some 100 countries in Africa, Asia and Latin America in projects covering practically every sector of agriculture, forestry, economic development, social services and institutional and physical infrastructure. – The GTZ is commissioned to do this work by the Government of the Federal Republic of Germany and by other national and international organizations.

GTZ activities encompass:

- appraisal, technical planning, control and supervision of technical cooperation projects commissioned by the Government of the Federal Republic of Germany or by other authorities
- advisory services to other agencies implementing development projects
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- provision of materials and equipment for projects, planning work, selection, purchasing and shipment to the developing countries
- management of all financial obligations to the partnercountry.

The series **"Sonderpublikationen der GTZ"** includes more than 190 publications. A list detailing the subjects covered can be obtained from the GTZ-Unit 02: Press and Public Relations, or from the TZ-Verlagsgesellschaft mbH, Postfach 36, D 6101 Roßdorf 1, Federal Republic of Germany.

TRAINING MODULES FOR WATERWORKS PERSONNEL

List of training modules:

Basic Knowledge

- **0.1** Basic and applied arithmetic
- **0.2** Basic concepts of physics
- **0.3** Basic concepts of water chemistry
- **0.4** Basic principles of water transport
- **1.1** The function and technical composition of a watersupply system
- **1.2** Organisation and administration of waterworks

Special Knowledge

- **2.1** Engineering, building and auxiliary materials
- **2.2** Hygienic standards of drinking water
- **2.3a** Maintenance and repair of diesel engines and petrol engines
- **2.3b** Maintenance and repair of electric motors
- **2.3c** Maintenance and repair of simple driven systems
- **2.3d** Design, functioning, operation, maintenance and repair of power transmission mechanisms
- **2.3e** Maintenance and repair of pumps
- **2.3f** Maintenance and repair of blowers and compressors
- **2.3g** Design, functioning, operation, maintenance and repair of pipe fittings
- **2.3h** Design, functioning, operation, maintenance and repair of hoisting gear
- **2.3i** Maintenance and repair of electrical motor controls and protective equipment
- **2.4** Process control and instrumentation
- **2.5** Principal components of water-treatment systems (definition and description)
- **2.6** Pipe laying procedures and testing of water mains
- **2.7** General operation of water main systems
- **2.8** Construction of water supply units
- **2.9** Maintenance of water supply units Principles and general procedures
- **2.10** Industrial safety and accident prevention
- **2.11** Simple surveying and technical drawing

Special Skills

- **3.1** Basic skills in workshop technology
- **3.2** Performance of simple water analysis
- **3.3a** Design and working principles of diesel engines and petrol engines
- **3.3b** Design and working principles of electric motors
- **3.3c** –
- **3.3d** Design and working principle of power transmission mechanisms
- **3.3e** Installation, operation, maintenance and repair of pumps
- **3.3f** Handling, maintenance and repair of blowers and compressors
- **3.3g** Handling, maintenance and repair of pipe fittings
- **3.3h** Handling, maintenance and repair of hoisting gear
- **3.3i** Servicing and maintaining electrical equipment
- **3.4** Servicing and maintaining process controls and instrumentation
- **3.5** Water-treatment systems: construction and operation of principal components: Part I - Part II
- **3.6** Pipe-laying procedures and testing of water mains
- **3.7** Inspection, maintenance and repair of water mains
- **3.8a** Construction in concrete and masonry
- **3.8b** Installation of appurtenances
- **3.9** Maintenance of water supply units Inspection and action guide
- **3.10** –
- **3.11** Simple surveying and drawing work

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