

┌

└

Operating Manual



BOD System

BOD System 6 – BOD System 10

Equipment for manometric measuring of BOD



Operating Handbook

Thank you for having chosen the equipment for manometric measuring of BOD.

Warnings:



Before using the instrument it is recommended to carefully read the operating manual supplied with the equipment. An improper use of the device and not as written in the manual can be dangerous for safety.



The instrument is classified as electrical/electronic apparatus and must be disposed of accordingly. The unit is subject to waste separation and cannot be disposed of as urban waste under EEC directive 2002/96/CE. For more information please contact the relative division of your local town council.

This tool should be used for laboratory applications only and for internal use only.

SAFETY

To move the unit, particularly when the bottles with the sample are included, use the special built-in handles on the sides of the instrument. Avoid moving or transporting the tool supporting it elsewhere.

The magnetic fields are active on magnetic or metallic pieces (magnetic supports, CDs, floppy discs, cardiac stimulators, magnetic cards). Keep these pieces far away from the magnetic stirrer plate and the magnetic stir bars.

CLEANING

The cleaning of the instrument must be performed, after removing the power supply, with a cloth moistened with non-flammable, non-aggressive detergents.

PERSONAL PROTECTIVE

The means of personal protection must be compatible with the risks arising from the reagents needed for the analytical procedures and glass bottles.

MAINTENANCE

For routine maintenance of the appliance see Maintenance chapter in this manual.

In accordance with the law on product warranty, all repairs of the instruments must be carried out at our office, unless otherwise arranged with the local distributors.

The instrument was designed and constructed in accordance with the following standards:

Safety requirements for electrical equipment for measurement and control and for laboratory use
Electrical equipment for laboratory use
General Requirements - Canadian Electrical Code

IEC/EN61010-1
UL 3101-1
CAN/CSA C22.2 No 61010-1

The manufacturer, in the commitment to constantly improve the quality of its products, reserves the right to vary specifications without notice.

CONTENTS

1.	Forewords	6
1.1	Supplied items	7
2.	Instrument description	8
3.	Assembly and installation	8
4.	Function checks	8
5.	Operation after work	9
6.	Maintenance	9
7.	Final decommissioning	9
8.	Optional accessories	10
9.	Spare parts	10
10.	Technical features	10
11.	Electric scheme	11
12	Analytical methods	12
12.1	Foreword	12
12.2	Methods for B.O.D. measurement	13
12.3	Required chemicals	14
12.4	Scale choice	15
12.5	Examples of experimental curves	16
12.6	Expected BOD ⁵ ₂₀ values	16
12.7	Sampling	17
12.8	Pre-treatments of samples	16
12.9	Neutralization of samples	17
12.10	Removal of free and combined chlorine	17
12.11	Removal of toxic metals	18
12.12	Inhibition of nitrification	17
12.13	Bacterial seed	18
12.14	Nutrients supply	18
12.15	Dilution water	19
12.16	BOD Standard	19
12.17	Example of BOD calculation	21
13.	Warranty	23
14.	Suggestions	23

1. Forewords

The microorganisms already present or purposely seeded in a water sample containing biodegradable organic matter use oxygen for their biochemical processes and produce an equivalent volume of carbon dioxide.

If the process develops in a closed system and the carbon dioxide is absorbed by a strong alkali, e.g. soda lime (sodium calcium hydrate, 20% about carbon dioxide absorption capacity) or potassium hydroxide, a progressive decrease of internal pressure can be measured.

Velp Scientifica developed according to international safety rules an innovative electronic equipment without mercury, **BOD Sensor**, that can be used with stirring equipment **System 6** or **System 10** for 6 or 10 BOD bottles.

BOD Sensor is screwed directly on each bottle: it is equipped by a pressure transducer microprocessor controlled which allows the recording of five BOD values measured at 24h intervals. At any time the progressive BOD value can be shown by the display, also after the standard five days (e.g. 21 days).

BOD Sensor is powered by two lithium micro batteries and thus it is free from any electric or hydraulic connection.

For sample incubation at a controlled temperature Velp Scientifica refrigerated thermostats are available:

FOC225E/I	For incubating five stirring System 6 or two System10 at the same time. Programmable temperature 0 ÷ 50°C
FTC90E/I	For incubating one stirring System 6 or 10, at a programmable temperature from 0 to 50°C
FTC90	For incubating one stirring System 6 or 10 at the fixed temperature of 20°C

1.1 Supplied items

Verify the integrity of the stirring system when received. The table below shows the elements contained in the packaging. Depending on the ordered model, check all the following components, packaged individually, as indicated in the column:

	BOD Sensor System 6	BOD Sensor System 10	BOD EVO Sensor System 6	BOD EVO Sensor System 6
	S10220136 S10230136 S10240136	S10220137 S10230137 S10240137	S10220156 S10230156 S10240156	S10220146 S10230146 S10240146
Sensor ¹	F102B0133	F102B0133	F102B0143	F102B0143
Stirring basis	F10220270 F10230270 F10240270	F10220280 F10230280 F10240280	F10220270 F10230270 F10240270	F10220270 F10230270 F10240270
Wireless DataBox ²	-	-	-	A00000218
Magnetic anchors	A00001056 N°6 pz	A00001056 N°10 pz	A00001056 N°6 pz	A00001056 N°6 pz
Dark glass bottles	10001107 N°6 pz	10001107 N°10 pz	10001107 N°6 pz	10001107 N°6 pz
Alkali containers	10000904 N°6 pz	10000904 N°10 pz	10000904 N°6 pz	10000904 N°6 pz
N°1 Power cable				
N°1 BOD Sensor identification label				

¹⁾ The sensor box contains the BOD EVO Sensor or BOD Sensor, with its instruction manual.

²⁾ The box contains the BODSoft™ receiver and its instruction manual.

NOTE: Keep in full the shockproof containers of the digestive system that may be needed for future shipping and transportation.

2. Instrument description



The stirring equipments BOD System 6 an System 10 allow the housing of 6 or 10 BOD bottles in a limited space. The two side embedded handles allow a easy introduction or removal of the equipment from a refrigerated thermostat, also with BOD bottles with samples into position. The stirring motor allows a continuous operation without risks of stopping or development of heat which could impair the measurements. Movement is transmitted by a belt to pulleys equipped by a purposely devised bearing.

3. Assembly and installation

Make sure the power supply is equal to the working voltage. Position the product in order that the main plug is easily accessible because it is considered disconnecting device. With all Velp Scientifica Refrigerated thermostat it's possible to supply the stirring system BOD System 6 or 10 using the external switch placed on the front of the refrigerated thermostat.

4. Function checks

To verify that all stirring points are operating, after connecting electrically the device, place a bottle on every stirring points and check that the anchor, previously inserted, is in motion.

5. Operations after work

After each test it's recommended not to leave the instrument connected to the power supply. After turning off the instrument clean it with a cloth moistened with non aggressive detergents.

When not using the system for some time it's better not to leave the BOD Sensors screwed on the bottles, in order to avoid useless stress on the alkali container lip that serves as seal and in case remove the batteries.

To wash the bottles after each test see next chapter *Maintenance*.

6. Maintenance

The ordinary and extraordinary maintenance of the instrument is not provided, except for periodic clearing of the instrument to be carried on as described in the previous paragraph.

After each analysis BOD bottles, magnetic anchors and alkali containers must be thoroughly washed using hot water, possibly with the help of a brush. Detergents are not recommended because these products have very high values of BOD, so even small traces can affect the outcome of the measures. The use of sulphoric chromium mixture is not recommended due to the high toxicity of the chromium towards the microorganisms and to the difficulty in removing the residual traces by simple rinsing.

7. Final decommissioning



For the final decommissioning, the instrument is in the category of electrical and electronic equipment and must be subject to separate collection and cannot be disposed of as municipal waste, as required by Directive 2002/96/EC. For more detailed information about recycling of these product, contact your local office in charge.

8. Optional accessories

Description	Code
Sensor Check	A00000135
Control test pads	A00000136

9. Spare parts

Description	Code
BOD Sensor	F102B0133
BOD EVO Sensor	F102B0143
Lithium batteries type CR2430	10000039
Magnetic anchor 6x35 mm	A00001056
Alkali container	10000904
Dark glass bottle 500 ml	10001107

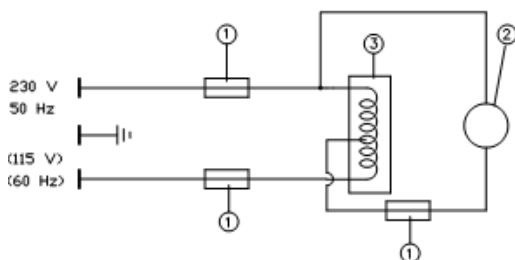
The spare parts mentioned above can be easily replaced by the operator. For other parts (and the complete list) contact the nearest Velp service center.

10. Technical features

BOD System 6 e 10

	BOD System 6	BOD System 10
Stirring places	6	10
Dimensions (BxHxP) mm	270x300x185	432x300x165
Weight kg	1	3
Power supply	230 V $\pm 10\%$ 50 Hz or 60 Hz or 115 V $\pm 10\%$ 60 Hz	
Power	2 W	
Stirring speed	60 rpm	
Safety class	I IEC/EN61010-1	
Max. altitude	2000 m	
Max. humidity	85 %	
Overvoltage category	II	
Pollution degree	2	
Max. noise level	52 dBA	
Fuses	250 mA 5x20 mm (230V) 500 mA 5x20 mm (115V)	
Admitted room temperature	Storage $-25 \div +65^{\circ}\text{C}$ Operation $+5 \div +40^{\circ}\text{C}$	

11. Electric scheme



- 1) 5x20 mm retarded fuse 63 mA
- 2) Motor
- 3) Transformer

12 Analytical methods

12.1 Foreword

Biochemical Oxygen Demand is related to the amount of biodegradable organic matter in a water sample.

During oxidative degradation of organic matter, aerobic microorganisms which perform it consume oxygen present in water as dissolved gas.

Biochemical Oxygen Demand is expressed as weight of oxygen consumed per unit volume of water during a defined period of time at a defined temperature, e.g. mg O₂/l (or ppm = parts per million) during 5 days at 20 °C.

The term Biological oxygen Demand is abbreviated as B.O.D., in France the corresponding abbreviation is DBO (Demande Biochimique en Oxygène), in Germany BSB (Biologischer Sauerstoff Bedarf).

To complete biological oxidation at 20 °C a period of time between 21 and 28 days is required (B.O.D._{last}, BOD₂₁, BOD₂₈).

Considering that these periods are very long in comparison to practical requirements, conventionally the measurement is performed after 5 days of incubation, during which time, at 20 °C, an amount of Oxygen is consumed corresponding roughly to 70% of total consumption after 21-28 days.

In comparison to the chemical method for Oxygen demand measurement (COD = Chemical Oxygen Demand) the relationship $COD = BOD_{21}$ does exist only for completely biodegradable substances, for example glucose.

Anyway many organic substances both natural or sintetic present in waters are not biodegradable (lignin) or can be degraded only slowly in the conditions adopted for the biological assay (cellulose) while on the contrary are quickly oxidized in the conditions adopted for the chemical assay (hot acid dichromate solution).

As a consequence in most of cases the COD value of a given water sample is higher than B.O.D. value but without any "a priori" definable relationship save well characterized wastewaters.

As a process performed by living microorganism, Oxygen demand is related to temperature and can be measured roughly between 0 °C and 50 °C according to the rate of acclimation of bacterial flora. The rate of consumption increases with temperature.

Standard and official methods require that incubation is to be performed at 20 °C, with an evident reference to average conditions in natural environment.

Anyway particular practical needs (warm or cold areas or seasons) allow to adopt incubation temperatures different from 20 °C.

B.O.D. measurements are mainly utilized for the evaluation of the amount of organic matter entering a biological wastewater treatment plant or its efficiency, but as well it is used in studies on surface water bodies (rivers, lakes, oceans).

Incubation is performed in the dark in order to avoid interferences due to oxygen production from algal photosynthesis.

12.2 Methods for B.O.D. measurement

Solubility of oxygen in water is limited. At sea level (760 mm Hg) maximum solubility in distilled water at 20 °C is 8.84 ppm (100% saturation) in equilibrium with humid air, whose oxygen content is 20.95% in volume (23.5% in weight). Solubility decreases with increasing altitude (lower pressure), temperature and salinity.

B.O.D. can be evaluated measuring the dissolved oxygen content (by titration or specific electrode) of a water sample at the start and at the end of incubation. It is imperative that a measurable amount of dissolved oxygen is still present at the end of incubation period; a zero value is meaningless.

Starting from an initial value near 100% saturation, only values lower than 8 mg/l dissolved oxygen or measurable B.O.D. can be available.

Liquid wastes with a B.O.D. equal to 100000-150000 ppm do exist, when in most cases values of hundreds or thousands of ppm are to be measured.

As a consequence the possibility of using dissolved oxygen measurement is subjected to dilution of water samples and to assemble series of dilutions aimed to avoid the occurrence of zero oxygen contents in all the samples at the end of incubation. Incubation is performed in unstirred bottles and the samples after being used for titration of oxygen content are no more useful.

Other methods supply continuously dissolved oxygen to the incubated samples.

In one case, the supplied oxygen to maintain constant the concentration is produced by electrolysis and the amount of electricity used for its production is converted to consumed oxygen. A simpler method measures manometrically oxygen consumption according to the same principle of Warburg's respirometer, widely used in biochemical research.

Samples with a B.O.D. lower than 800-900 ppm do not need dilution. Samples with very high B.O.D. are to be diluted to an extent much lower than that required by titration method and all this corresponds to operate in conditions more similar to those existing in the treatment plant or the natural environment to be controlled.

The sample is continuously stirred avoiding the onset of concentration gradients.

The supply of oxygen is continuous and made easy by stirring, giving to the sample mean concentrations which are far from possible extreme values (100% saturation or anoxia).

12.3 Required chemicals

A) For carbon dioxide absorption.

- Potassium hydroxide (KOH) scales, commercial grade (it is not required particularly pure).

or

- Soda lime not deliquescent, 1.0-1.7 mm granules.

B) If samples are to be neutralized before incubation:

- Sulfuric acid (H_2SO_4) 1.0 N solution.
- Sodium hydroxide (NaOH) 1.0 N solution.

C) If samples are to be supplemented with nutrients:

- Distilled water, high quality, free of copper and organic matter.
- Iron chloride, ferric, exahydrate ($\text{FeCl}_3 \bullet 6 \text{H}_2\text{O}$).
- Calcium chloride, anhydrous (CaCl_2).
- Magnesium sulfate, heptahydrate ($\text{MgSO}_4 \bullet 7 \text{H}_2\text{O}$).
- Potassium ortophosphate, biacid, (KH_2PO_4).
- Potassium ortophosphate, monoacid, (K_2HPO_4).
- Sodium ortophosphate, monoacid, (Na_2HPO_4).
- Ammonium chloride (NH_4Cl).

D) If samples contain chlorine:

- Sodium sulfite (Na_2SO_3).

E) If nitrification in samples is to be inhibited:

- Allyl thiourea (Thiosinamine), $\text{C}_4\text{H}_8\text{N}_2\text{S}$.

or

- 2-chloro-6 (trichloromethyl) pyridine, $\text{C}_6\text{H}_3\text{Cl}_4\text{N}$ (CTCMP, N- Serve).
Additive for mineral fertilizers aimed to lower nitrogen losses in soils.

12.4 Scale choice

The apparatus measures B.O.D. values lower than 90-250-600-1000 ppm respectively. If a preliminary information about the probable B.O.D. value of samples under examination is available, the choice of the scales to be used is easy.

Samples with a B.O.D. value higher than 900-950 ppm are to be diluted accordingly before starting the measurement, using if necessary subsequent dilutions in order to maintain significance to the volume of sample used, particularly when turbid or viscous solutions are examined.

For example: 50 ml of sample measured by a 50 ml graduated cylinder diluted to 500 ml by a 500 ml graduated cylinder using high quality distilled water (distilled in presence of permanganate) and with nutrients added (see par. 12.13): obtained dilution 1:10.

Subsequent dilutions are obtained in the same way, stirring the diluted sample by a clean glass or plastic rod in order to homogenize it.

Final result is to be multiplied by dilution ratio which is recorded immediately after performing it. When no preliminary information about the sample B.O.D. is available a series of three bottles is to be prepared, containing respectively the undiluted sample, a 1:10 dilution and a 1:100 dilution choosing scales according to the highest known B.O.D. value for samples belonging to the same class of the sample under examination (animal wastes, industrial wastewaters, etc. see par. 12.6).

Scale	Volume of sample
A: $0 \div 1000 \text{ mg O}_2/\text{l}$	100 ml
B: $0 \div 600 \text{ mg O}_2/\text{l}$	150 ml
C: $0 \div 250 \text{ mg O}_2/\text{l}$	250 ml
D: $0 \div 90 \text{ mg O}_2/\text{l}$	400 ml

The scales give directly the value of consumed oxygen as $\text{mg O}_2/\text{l}$, after a defined period of time.

The possibility of measuring diluted samples extends the range of measures. For the preparation of dilution water see chapter 12.15.

12.5 Examples of experimental curves

To make sure that aerobic degradation of substances present in the examined samples develops regularly every day the B.O.D. values are recorded and plotted. The following criteria are to be remembered:

- 1) The amount of oxygen consumed daily lowers progressively in comparison to the amount consumed the day before.
- 2) The cumulative amount of consumed oxygen increases progressively until a quasi constant value is reached.

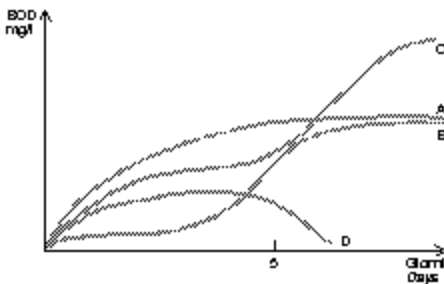
The following curves are examples of typical situations:

A) Typical curve for carbonaceous matter degradation when a suitable bacterial flora and adequate amounts of nutrients are present.

B) Trend due to the presence of a low number of bacteria adapted to the substratum when incubation started or to the presence of inhibitors of bacterial development.

C) When oxygen consumption starts to increase again, typically during the 6th or 7th day from start, there are nitrifying bacteria developing by oxidation of reduced nitrogen compounds (ammonia) to nitrite. It is possible to avoid this effect by using nitrification inhibitors (see para. 13.11).

D) It is due to losses in the seals of the apparatus.



12.6 Expected BOD⁵₂₀ values

The symbol states that the values refer to a 5 day incubation at 20°C.

The following values can be useful as guidelines in choosing scales and dilutions to be performed.

The appraisal can be obtained also if a value of produced weight, for example: 65 g B.O.D./inhabitant/day and the corresponding volumes of used water are available. With a consumption of 150 l/inhabitant/day the corresponding BOD⁵₂₀ value will be 450 mg/l about, while 400 l/inhabitant/day will lower the BOD⁵₂₀ of raw sewage to 160 mg/l about.

Untreated waste	BOD mg/l
Paper factories	200-4000
Tanneries	500-1500
Distilleries	12000-35000
Oil mills	15000-70000
Dairies	200-6000
Slaughter houses	1000-2500
Textile printing and dyeing	1000-12000
Piggeries	7000-9000
Pharmaceutical industry	800-10000
Domestic water	800-2000

12.7 Sampling

Collect the water sample in a clean tank, if the analysis begins within 2 hours it is not necessary to cool the sample to 4 °C. Otherwise, keep the sample below 4 °C. The sample must not be stored for more than 24 hours.

During BOD analysis on samples without pre-treatment the suspended material may not be well mixed and therefore the oxygen consumption in one bottle may be faster than in another. In order to obtain repeatable results without damaging the microorganisms, homogenize the sample using a magnetic stirrer.

12.8 Pre-treatments of samples

In many cases a water sample must be subjected to proper pre-treatment before B.O.D. measurement:

- A)** When the pH value is not in the range 6.5-7.5.
- B)** If the sample is disinfected by chlorine, chlorine dioxide, ozone, etc.
- C)** If substances toxic to bacteria are present.
- D)** If the water is rich in nitrifying bacteria.
- E)** When the bacterial flora is poor.
- F)** When the nutrient content (nitrogen, phosphorus, microelements) is too low.

Many of these cases refer to industrial wastewaters.

12.9 Neutralization of samples

The optimum pH for bacteria is between 6.5 and 7.5. Outside this range the results of the BOD are lower than what they should be. It is therefore necessary to adjust the pH value using 1.0 N solutions of sulphuric acid or sodium hydroxide respectively. The added volume of acid or base should not exceed 0.5 % of sample volume. If necessary, more concentrated solutions should be used.

12.10 Removal of free and combined chlorine

Disinfecting agents containing chlorine are normally used for eliminating bacteria. In order to determine the BOD value of samples containing disinfectants it is necessary to eliminate the free and combined chlorine by adding small volumes of sodium sulphite solution about 0.025 N (1.58 g / l in distilled water). This solution is unstable and must be used within a day. Disinfected samples require a bacterial seed after disinfectant removal.

12.11 Removal of toxic metals

Some industrial wastewaters (e.g. metalplating) do contain toxic metals. If the pH of these wastewaters is brought to 8.5 most metals are precipitated as oxides or hydroxides and removed by filtration. The pH is then brought within 6.5 and 7.5 and a bacterial seed is added. In some cases a toxicity reduction can be obtained by simply diluting the sample. The problem of toxicity in samples usually requires particular investigations.

12.12 Inhibition of nitrification

Sometimes it is required to exclude from B.O.D. measurement the contribution due to nitrification; e.g. biologically treated effluents, samples seeded with biologically treated effluents, river waters.

Nitrification usually starts after five days (at 20 °C) and therefore its influence on B.O.D. evaluation is minimal. If nitrifying bacteria are present in large numbers in the sample under examination, their activity can be inhibited by adding a chemical agent.

According to Italian Official Methods for Water Analysis (CNR-IRSA Method E-008, 1981) this is obtained by adding to each B.O.D. bottle the following volumes of a 0.05% solution of allylthiourea (ATU) (50 mg in 100 ml of water):

Volume of sample	Volume of inhibiting solution
ml 100	ml 0,3
ml 150	ml 0,5
ml 250	ml 0,8
ml 400	ml 1,3

ATU solution should be kept at 4 °C in a dark room. The solution is stable for at least 2 weeks.

According to APHA-AWWA-WPCF Standard Methods (U.S.A.) the same result can be obtained by adding the same shown volumes of a 0.35% solution of 2-Chloro-6 (trichloromethyl) pyridine TCMP (350 mg in 100 ml of water). If a nitrification inhibitor is used this must be recorded and shown with results.

12.13 Bacterial seed

If the sample does not contain a sufficient amount of bacteria, for example in the case of industrial wastewaters, or if type B curves as described in par. 12.5 are obtained, it is necessary to seed samples with bacteria to start oxygen uptake.

A quantity of water withdrawn a few kilometers downstream of the discharge water can be used as a seed, alternatively it's possible to use river or lake water containing waste from urban sewage. In addition there are now ready-to-use bacterial inoculants on the market for BOD.

Usually a seed volume equal to 10% is used. A municipal wastewater supernatant can show B.O.D. values from 50 to 300 ppm which vary also during the 24 hours.

The seed B.O.D. (blank) must be measured at the same time of that of seeded samples, after dilution with high quality distilled water using the same ratio used to seed the samples (e.g. 100 ml/l).

The B.O.D. of seed is to be subtracted from the values obtained with seeded samples. The start of oxygen uptake is related to seed quality. Sometimes increasing seed volumes are to be used, for example 100-200-300 ml per liter of sample. At the end of incubation, the highest value after the subtraction of seed B.O.D. will be considered valid.

12.14 Nutrients supply

Again when industrial wastewaters are examined, it is to be assumed that the so called nutrients (nitrogen, phosphorus and micronutrients) are absent or present in insufficient amounts for a regular development of bacterial flora. In these cases it is necessary to add nutrients by using the following solutions:

Solution A – dissolve 0.25 g of ferric chloride exahydrate ($\text{FeCl}_3 \bullet 6 \text{H}_2\text{O}$) in 1 l of distilled water.

Solution B - dissolve 27.5 g of calcium chloride anhydrous (CaCl_2) in 1 l of distilled water.

Solution C - dissolve 22.5 g of magnesium sulfate heptahydrate ($\text{MgSO}_4 \bullet 7 \text{H}_2\text{O}$) in 1 l of distilled water.

Solution D (buffer) - dissolve 8.5 g of potassium monobasic phosphate (KH_2PO_4), 33.4 g of disodium phosphate heptahydrate ($\text{Na}_2\text{HPO}_4 \bullet 7 \text{H}_2\text{O}$), 21.7 g of dipotassium phosphate (K_2HPO_4), 1.7 g of ammonium chloride, ($\text{NH}_4 \text{Cl}$) in 1 l of distilled water.

Final pH = 7.2. Samples without nutrients with a B.O.D. lower than 800-900 ppm are added with 1 ml of each solution (A-B-C-D) for each liter of sample.

For samples without nutrients and BOD values of below 800-900 ppm, add 1 ml of each solution (A, B, C and D) per litre of sample.

12.15 Dilution water

When samples to be diluted are examined it is a good idea to prepare dilution water by adding nutrients to distilled water. Add 1 ml of each solution (A, B, C and D) to each litre of distilled water. This dilution water should have a B.O.D.₅₂₀ no higher than 0.2 ppm.

When high dilution factors are used (1:100, 1:1000) and there are doubts about the distilled water used for dilutions it is a good idea to measure the B.O.D. of dilution water, this value should then be subtracted from the value obtained for the diluted sample before multiplying the result by the dilution factor.

12.16 BOD Standard

The precision of method can be evaluated by using solutions with a known content of D-glucose ($C_6H_{12}O_6$) and L-glutamic acid ($C_5H_9NO_4$), pure grade and previously dried at $(105 \pm 5)^\circ C$ for 1 hour. Dissolve (150 ± 1) mg of both reagents in 1000 ml of distilled water.

Introduce 250 ml of this solution into the bottles and use 250 ppm scale.

The empiric BOD₅₂₀ value is 210 ± 20 mg O₂/l and the BOD₇₂₀ is 225 ± 20 mg O₂/l.

In the same way it is possible to use sodium acetate solution 50 mg/L.

Introduce 400 ml of this solution into the bottles and use 90 ppm scale.

The empiric BOD₅₂₀ value is 31 ± 5 mg O₂/l.

The solutions must be prepared using tap water, and if necessary, added with nutrients (1 ml/l of each previously described solutions, A to D) and seeded with bacteria.

To check the manometric measuring of the BOD EVO System the control test tablets (code A00000136) can be used.

With this test it is possible to perform an oxygen demand experiment analogous to the BOD method. Introducing a tablet a certain amount of oxygen in the test is chemically absorbed.

Using a scale of 600 the expected value is 314 ± 30 mg O₂/l.

Using a scale of 999 the expected value is 440 ± 40 mg O₂/l.

12.17 Example of BOD calculation

In an incubation bottle are introduced 250 ml of a sample diluted 1:10 with distilled water, seeded with 1 or 2 ml of biological sludge.
After 5 days a BOD of 200 mg/l is read.

In another bottle is introduced the same amount of distilled water and seed and, after 5 days, a BOD of 15mg/l is read (blank value).

The real BOD value, considering the dilution of the sample, is:

$$\text{real BOD} = (200-15) \times 10 = 1850 \text{ mg/l}$$

Collecting data table:

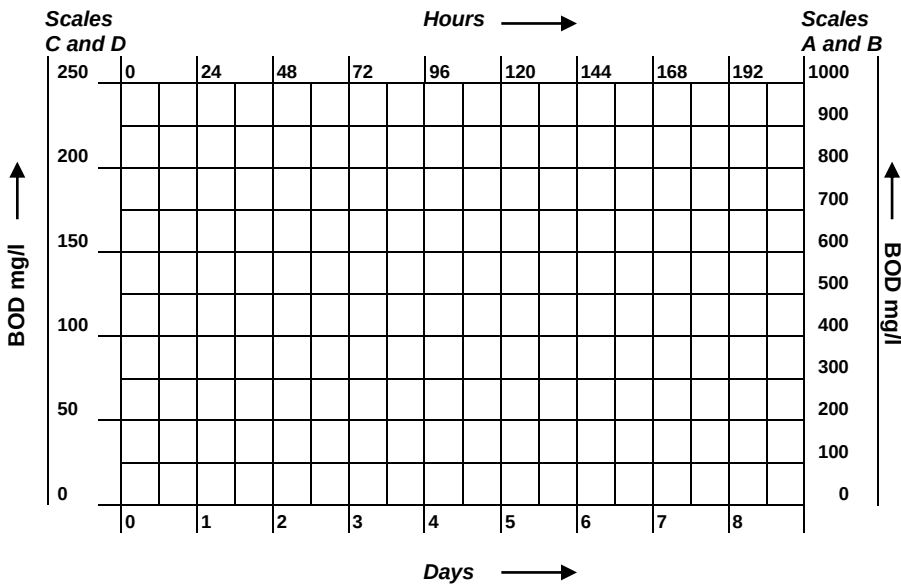
Sample

Location	1	2	3	4	5	6
N° sensor						
Scale						
Volume						
Dilution						
BODn result						

Recording the values of BOD on the following chart, it is possible to build the BOD curve.
Using the Wireless mode, this curve will be created automatically by the software.

Date:
Hour of incubation start:
Analyst:

Graph for B.O.D. curve recording:



13. Warranty

The unit is guaranteed against production defects for **25 months** from our invoice date.

Warranty claims can be made only if the system has been installed and used as specified on the manual and carried out by qualified service personnel as appointed by VELP Scientifica.

In accordance with this guarantee VELP SCIENTIFICA undertakes to repair any instruments resulting as faulty due to the quality of the materials used or poor workmanship.

Faults arising due to inexperienced handling/use or carelessness will not be replaced or repaired under warranty.

For more details please contact your Distributor.

Exclusions:

The warranty will be considered null and void for faults resulting from:

- inexperience and carelessness of the customer
- repairs, maintenance or replacements carried out by unauthorised third parties
- use of the instrument not in accordance with the instructions/recommendations given in this operator manual
- use of non-original spare parts.

14. Suggestions

Send us your valuable suggestions and advices with the goal of continuously improving these instructions.

e-mail: service@velp.it

Conformity declaration

We the manufacturer	VELP SCIENTIFICA s.r.l.
Address	Via Stazione, 16 20865 USMATE (MB) Italy

under our responsibility declare that the product is manufactured in conformity with the following standards:

EN 61010-1 (2001)
EN 61326-1 (2006)
2011/65/EU (RoHS)
2002/96/EC (WEEE)

and satisfies the essential requirements of the following directives:

Machinery directive 2006/42/EC

Low voltage directive 2006/95/EC

Electromagnetic compatibility directive 2004/108/EC

plus modifications and that the documents listed in annex I are available at Velp's offices as foreseen by the machinery directive.

Thank you for having chosen a VELP product !

Since 1983 Velp has offered to professionals in the sector a range of sophisticated and reliable equipment with excellent operating capacity and backed by high levels of know-how at competitive prices.

Velp works according to ISO 9001, ISO14001 and OHSAS 18001 Quality System Certification. Instruments are built according to the International norms IEC 1010-1 and to the rules of the CE mark.

Let us present our product Lines:



Environment

Thermoreactors ECO series
B.O.D. Determination systems
Refrigerated thermostats
Cooled Incubators
Flocculators
Overhead mixer
Mineralization system for heavy metals trace determination
Turbidimeter
Radiation Detector

Stirring

Heating magnetic stirrers
Vertex digital thermoregulator
Ultraflat magnetic stirrer
Magnetic stirrers
Overhead stirrers
Heating plates
Vortex mixers
Homogenizer

Food&Feed

Digesters DK series
JP Recirculating Water Pump for fumes aspiration
SMS Scrubber
Distillation Unit UDK series
Solvent extractors
Raw fiber extractors
Dietary fiber extractors
Laboratory aids
Oxitest Oxidation Test Reactor

Pumps

Recirculating water vacuum pump
Peristaltic pumps