KLM Technology Group
#03-12 Block Aronia,
Jalan Sri Perkasa 2
Taman Tampoi Utama
81200 Johor Bahru
Malaysia

PROCESS DESIGN OF PLANT WASTE WATER SEWER SYSTEMS

(PROJECT STANDARDS AND SPECIFICATIONS)

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SCOPE

This Project Standards and Specifications covers minimum requirements for the process design of plant waste water sewer systems as well as plant waste effluent sources and disposals relevant to oil and gas refineries, chemical plants, oil terminals, petrochemical plants and other facilities as applicable.

REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

1. ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 748	"Hydrometry-Measurement of Liquid Flow in Open Channels Using Current- Meter or Floats"
ISO 772	"Hydrometry Determination - Vocabulary and Symbols"
ISO 1070	"Liquid Flow Measurement in Open Channels-Slope-Area Method"1997
ISO 1100-1,	"Measurement of Liquid Flow in Open Channels-Part 1: Establishment and Operation of a Gaging Station" 1996
ISO 1100-2,	"Measurement of Liquid Flow in Open Channels-Part 2: Determination of the Stage - Discharge Relation"1998
ISO 3847	"Liquid Flow Measurement in Open Channels by Weirs and Flumes"

2. API (American Petroleum Institute)

API PUBL. 4655	"Field Evolution of Biological and Non-Biological Treatment Technologies to Remove MTBE/Oxygenates from Petroleum Product Terminal Waste Waters"
API PUBL. 4665	"Analysis and Reduction of Toxicity in Biologically Treated Petroleum Product Terminal Tank Bottoms Water"

3. HR (Hydraulic Research)

"Charts for the Hydraulic Design of Channels and Pipes", 6th. Ed.

"Tables for the Hydraulic Design of Pipes and Sewers", 7th. Ed Ackers, p.

"Resistance of Fluids Flowing in Channels and Pipes, Hydraulics Research Papers No. 1 , HMSO 1958 J. A. Fox "An Introduction to Engineering Fluid Mechanics" , Published by Macmillan Press.

DEFINITIONS AND TERMINOLOGY

For definition of the particular terms/words of this Standard not outlined herein below, reference should be made to the latest revision of the following standard/publication:

API Vol. I "Manual on Disposal of Refinery Wastes, Volume on Liquid Wastes"

Biochemical Oxygen Demand (BOD) - Biochemical oxygen demand is oxygen demand by microorganisms during stabilization of organic matter under prescribed conditions, usually over a 5 day period, BOD5 specifically denotes the oxygen demand over a 5 day period at 20°C.

Branches - Branches are collection from various drain funnels, catch basins and area drains and tie into sublaterals. They are called T, Y, T-Y, double Y, and V branches according to their respective shapes.

Catch Basins - Catch basins are used to collect surface drainage and process wastes in individual drainage areas and to trap sediment at the point nearest the source.

Catchment Area - Catchment area is an area defined by a number of effluent streams which have a common discharge directed into a surface water drainage system, or water course.

Chemical Oxygen Demand (COD) - Chemical oxygen demand (COD) is the equivalent amount of oxygen consumed under specified conditions in the chemical oxidation of the organic and oxidizable inorganic matter contained in a

wastewater, corrected for the influence of chlorides. In American practice, unless otherwise specified, the chemical oxidizing agent is hot acid dichromate.

Contractor - Contractor is the person, firm or company whose tender has been accepted by the Company and includes the Contractor's personnel representative, successors and permitted assigns.

Disposal Well - Disposal well is a deep well used for the disposal of liquid wastes.

Dissolved Oxygen (DO) - Dissolved oxygen (DO) is the oxygen dissolved in sewage, water, or other liquid, usually expressed in milligrams per liter or percent of saturation. It is the test used in BOD determination.

Drains - Drains are small sewer connections discharging through a sealed connection to the nearest catch basin from points such as pump bases, equipment drips, low points of floors, funnels, etc.

Drip System - Drip system is a separate drain system for recovery of oil from contaminated fluids.

Effluent - Effluent is (1) a liquid which flows out of a containing space, and/or (2) sewage, water or other liquid, partially or completely treated, or in its natural state, as the case may be flowing out of a reservoir, basin, or treatment plant, or part thereof.

Effluent Limitation - Effluent limitation is any restriction (including schedules of compliance) established by a governmental authority on quantities, rates and concentrations of chemical, physical, biological and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean.

Immediate Oxygen Demand (IOD) - Immediate oxygen demand (IOD) is the amount of oxygen that is utilized by the components of a waste water within 15 minutes (unless otherwise specified) after being introduced into water that contains dissolved oxygen.

Laterals - Laterals is sewers collecting the effluent from two or more sublaterals discharging to "Mains".

Mains - Mains are sewers collecting effluent from laterals or sublaterals.

Manholes - Manholes are used in sewer mains as junction points and sediment traps, and to provide access for maintenance and inspection.

Oil Interceptor - Oil interceptor is a device designed to remove small oil globules by gravity from the water by limiting the flow velocity and the overflow rate.

Oxidation Ponds - Oxidation ponds are basins in which waste water undergoes a biological oxidation treatment by action of algae and bacteria.

Direct Oxidation - Direct oxidation is oxidation of substances in sewage without the benefit of living organisms, by the direct application of air or oxidizing agents such as chlorine.

Oxidation Sewage - Oxidation sewage is the process whereby, through the agency of living organisms in the presence of oxygen, the organic matter that is contained in sewage is converted into a more stable or a mineral form.

Oxygen Consumed - Oxygen consumed is the quantity of oxygen taken up from potassium permanganate in solution by a liquid containing organic matter. Commonly regarded as an index of the carbonaceous matter present. Time and temperature must be specified.

Parts Per Million (ppm) - Parts per million (ppm) is parts by mass in sewage analysis, ppm by mass is equal to milligrams per liter divided by the relative density (specific gravity). In water analysis ppm is always understood to imply mass/mass ratio (mg/kg), even though in practice a volume may be measured instead of a mass.

Primary Treatment - Primary treatment is water purification based on the difference in density of the polluting substance and the medium, the former being removed either by rising or settling. This process can include screening, grit removal, sedimentation, sludge digestion, and sludge disposal.

Run-off - Run-off is that part of rainfall which flows off the surface to reach a sewer or river.

Seals (Hydraulic Seals) - Seals (Hydraulic Seals) are used to isolate various parts of a sewer system, preventing vapor travel and spread of fire or explosion.

Sewage - Sewage is the fluid discharged from medical, domestic, and industrial sanitary appliances.

Sewage System - Sewage system is any of several drainage systems for carrying surface water and sewage for disposal.

Sewer - Sewer is an underground pipe or open channel in a sewage system for carrying water or sewage to a disposal area.

Sewerage - Sewerage is a system of sewers and ancillary works to convey sewage from its point of origin to a treatment works or other place of disposal.

Sludge Lagoon - Lagoon sludge is a relatively shallow basin, or natural depression, used for the storage or digestion of sludge, sometimes for its ultimate detention or dewatering.

Springing - Springing is separation of acid oils, either phenolic or naphthenic, by neutralization of spent caustic solutions. The acid oils are known as "sprung acids".

Storm Water - Storm water is rain water discharged from a catchment area as a result of a storm.

Sublaterals - Sublaterals are sewer branches [min. 150 mm (6 inch) Diameter Nominal size] collecting effluents from catch basins and convey it to the laterals.

Surface Water - Surface water is natural rain water from the ground surface, paved areas and roofs plus occasional courtyard and car washing waste waters and incidental fire fighting water.

Toe Walls - Toe walls are raised curbs which control spillage and drainage of storm, process and fire water.

Total Organic Carbon (TOC) - TOC is a measure of the amount of carbon in a sample originating from organic matter only. The test is run by burning the sample and measuring the CO2 produced.

Unit or Units - Unit or Units refer to one or all process, offsite and/or utility Units and facilities as applicable to form a complete operable refinery and/or complex.

SYMBOLS AND ABBREVIATIONS

SYMBOL/ABBREVIATION	DESCRIPTION
BOD5	The 5 Day Biochemical Oxygen Demand at 20°C
COD	The Total Chemical Oxygen Demand
DN	Diameter Nominal, in (mm)
DO	Dissolved Oxygen
DOD	Dissolved Oxygen Demand
EPA	Environmental Protection Agency
GRE	Glass-Fiber Reinforced Epoxy
IOD	Immediate Oxygen Demand
LNG	Liquefied Natural Gas
MEK	Methyl Ethyl Ketone
MTBE	Methyl Tertiary Butyl Ether
NGL	Natural Gas Liquids
TDS	Total Dissolved Solids
TEL	Tetra Ethyl Lead
TOC	Total Organic Carbon
TSS	Total Suspended Solids
Sewer Systems Symbols	
AMN	Amine Drains
CAU	Spent Caustic Sewer
CDH	Closed Drain Headers
CSW	Chemical Sewer
DWA	Desalter Waste Water
NSW	Non Oily Sewer Water
OSW	Oily Sewer Water
SSW	Sanitary Sewer Water
SWA	Stripped Sour Water
WAT	Treated Water
WSW	Storm Water Sewer

UNITS

This Standard is based on International System of Units (SI) except where otherwise specified.

GENERAL

All waste water effluents from the industries which are discharged to public and/or natural water sources or directed to recycling purpose inside the industry and may contain a wide variety of matters in solution or suspension should be controlled according to the requirements imposed by the final destination. However, in any case elimination of the waste or the hazard potential of the waste shall be ultimate goal in the management of hazardous wastes. Under no circumstances shall the effluent water cause oil traces on the surface or embankments of the receiving water, or affect the natural self purification capacity of the receiving water to such an extent that it would cause hindrance to others.

Under no conditions shall polluted streams be combined with unpolluted streams if the resultant stream would then require purification. In general main sewer systems in the industry shall be segregated according to the following categories:

- Storm Water Sewer System.
- Oily Water Sewer System.
- Non Oily Water Sewer System.
- Chemical Sewer System.
- Sanitary Sewer System
- Special Sewer Systems

In all areas including process, offsite and utility Units, provisions shall be made to foresee any of the above mentioned sewer systems as required.

INDUSTRIAL MAIN SEWER SYSTEMS

Storm Water Sewer System

This system shall consist of pipes and open ditches collecting clean and/or oily storm waters, fire and washing waters from the non-polluted areas.

The storm water shall be disposed to the oily storm water basin located in the waste water treatment area through the storm water network. It shall mainly collect the following non-polluted areas clean waters:

- Diked and undiked tank areas
- Unpaved areas

- Process and utilities non-polluted paved areas (excluding concrete paved areas)
- Roads, yards and roofs

The collected storm water after oil removal in the oily storm water basin shall be stored in the clean storm water basin.

The final disposal of such clean waters will be to:

- Waste water treating Unit at API separator(s) effluent for further oil removing.
- Evaporation pond(s)
- Ocean/river if complies with the local conditions of effluent waste streams

Oily Water Sewer System

This sewer shall collect:

- Process spillages and drainages
- Drains of all hydrocarbon equipment
- Pumps and compressors cooling water
- Oily condensate
- Cooling water drains which have a chance of becoming polluted with oil
- Waters coming from all hydrocarbon pollutable paved areas mainly including the following:
  - Process Units
  - Utilities
  - Non-volatile products truck loading stations
  - Workshop
  - Transport & mobile plant garage
  - Pump stations
- Pipe trench drains
- Sample point drains
- Drainage from level gages, cocks and similar equipment
- Drains of the following fluids are excluded because of flowing in pit for truck disposal:

- Heavy viscous fluids such as asphalt
- Motor gasoline contaminated with TEL
- Any fluid containing hazardous materials with concentrations more than allowable figures set out by the environmental and/or biological treatment restrictions

The system shall consist of drains, funnels, underground piping, clean-outs, catch basins, manholes, sealed manholes and vent pipes. The final main of the oily water sewer shall flow into API separator(s) in Waste Water Treating Area through a dedicated underground gravity flow network. Open ditches shall be avoided. Leakages of manifolds can be collected in a suitable collecting basin, located underneath the manifold. The basin shall drain into a sump located outside the manifold/piping area. The sump can be emptied intermittently (e.g., by vacuum truck) or it can be connected to the continuously oil contaminated drain system.

Non-Oily Water Sewer System

The system shall collect special oil free waters containing high total dissolved solids such as:

- Boiler blow-down
- Desalination Unit blow-down
- Brine drainage
- Neutralized effluents from all neutralization sumps through the plant
- Storm, fire and washing run-off waters from sulphur solidification and crushing area after removal of sulphur particles through a sedimentation sump
- Tempered water system drains
- Cooling water (circulated) blow-down and drains, provided that there is no possibility of oil contamination

The system shall consist of drains, funnel, underground piping, clean-outs, catch basins, manholes, sealed manholes and vent pipes. The non-oily water sewer system can be directed to the following disposals where required:

1. Waste Water Treatment Plant Effluent, if it is intended to reuse the treated waste waters as cooling tower make-up, in this case, the recycled treated water should meet the cooling tower make-up minimum requirements.

If needed, total hardness removal facilities should be provided on the nonoily water system before any disposal.

2. Waste Water Treatment Plant Inffluent [at API separator(s) outlet], if non-oily waters need further physical and/or biological treatment in order to meet the final disposal requirements. In this case the following conditions should be met.
   a. Non-Oily waters should be treated for total hardness removal before any disposal to the API separator(s) effluent (if required).
   b. All materials which will suffer the biological treatment activities should be removed from the nonoily waters.
3. Evaporation pond(s).
4. Public waters (if non-oily waters are complied with the Environmental Regulations).

However, non-oily water sewer system should be investigated for an appropriate disposal considering the following aspects:

- Environmental Regulations
- Availability of refinery/plant raw water
- Economical aspects
- Operability of equipment furnished

Chemical Sewer System(s)

1. General

   In this Engineering Standard all sewer systems containing acids, alkalides, chemicals and all other special organic materials such as Furfural, MEK, etc. are designated by "Chemical Sewer". Number and route of chemical sewer systems in a plant shall be studied based on the geographical location of various Units and more feasibility of the gathering and disposal systems. Chemical sewer streams shall include but not be limited to:

   - Polluted drains from chemical additives dosing pumps (excluding tetraethyl lead).
   - Laboratory building drains (excluding oily drains).
   - Drainage and storm water polluted by acid and/or other chemicals.

- Caustic drains (caustic dissolving Unit drains are excluded and shall have a closed circuit network inside the Unit).
- All waters contaminated with acids and/or chemicals.

2. Disposal of chemical sewers

   In general, disposal of any chemical sewer before neutralization/treatment to the environment should be avoided. Segregated chemical sewer network(s) shall be provided depending on variety of the chemicals disposed. Neutralization ponds effluent shall be connected to the non-oily sewer. The volume of the neutralization pond shall be minimum equal to the highest batch volume among the streams disposed. Chemical effluents from the laboratory building shall flow into a dedicated neutralization pit near the laboratory itself.

3. Neutralization systems

   a. Adequate facilities for acid and caustic injection systems, agitator, pumps, eductor (if required), steam coil (if required for winterization), etc., shall be provided for each neutralization pond.
   b. Necessary instrumentation such as acid and caustic flow indicator, pH indicator, pH low and high alarm in the control room, temperature controller, etc. to be foreseen for each pond.
   c. Type of operation (manual or automatic) for the neutralization ponds will be instructed by the Company.
   d. All acid and caustic handling facilities such as pipes, tanks, pumps, etc., shall be traced for proper temperature maintaining.

4. Type of chemicals wastes

   Chemical wastes shall include all wastes contaminated with acids, alkalides, chemicals and additives and waters containing hazardous liquids. Disposal of any stream containing hazardous materials to the oily sewer and/or nonoily sewer systems should be avoided before implementation of the necessary treatment processes for removal of the hazards.
   Method and extent of treatment will be instructed by the Company. The final treated water specifications shall be complied with the Environmental Pollution Requirements set out by the authorities concerned in Iran. Type of chemical wastes in general shall include but not be limited to:

   a. Waters containing hazardous materials which shall be segregated and handled separately.

b. Special chemicals with dedicated network.
c. Chemical terminated at the neutralization ponds

5. Sanitary Sewer System

This sewer shall collect non-polluted raw sanitary from sanitary facilities of all buildings as required. The final main shall flow into sanitary sewage treatment Units. The sanitary sewage treatment plant effluent in case of compliance with the required effluent characteristics can be routed to the Waste Water Treating Plant (at the biological treatment outlet) for recycling purpose.

6. Special Sewer Systems

Special sewer systems shall be provided where required. In general all fluids containing poisonous/hazardous materials and/or fluids subject to recovery shall be segregated and handled apart from the all other sewer systems mentioned in this Engineering Standard. The systems shall include but not be limited to the following streams:

- Caustic drains inside the Caustic Dissolving Unit
- Amine drains
- Solvent drains
- Motor gasoline drainage contaminated with TEL or MTBE
- Hydrocarbon drains containing benzene in concentrations more than allowed by the Environmental Regulations.
- All drains contaminated with toxic components such as cyanide, phenol, lead, etc.
- Aluminum chloride drainage
- Hydrofluoric acid drainage
- Spent catalysts
- Others

Any special requirement for segregation of the above streams, methods of in-plant pretreatment and the ultimate disposal shall be in accordance with the Company's instructions and/or the Environmental Regulations.