ANNEX J
DESIGN RELATED ALTERNATIVES

Annex J

1.1 Design-related Alternatives

As phase II is an expansion of the already existing WWTP facilities, its design was governed by the need of conciliating phase II with phase I and taking profit of the operation experience acquired until date.

Therefore, the technology chosen was the same than for phase I (which accomplishes with the principle of using the "best available technologies") with modifications/upgrading where needed: the final design is the result of reconciliation between design parameters, such as very high treatment efficiency, with low construction and operating costs.

With the aim of preserving the existing plant (phase I), equipment has been added on the existing water lines to adapt them to the high inlet concentrations. Taking advantage of the site experience the new design is the consequence of the following main process issues:

1- The inlet concentrations:
   - The ratio TSS/DBO has increase from last project, this result in a higher TSS load to the plant and a primary sludge production more important, which we have considered in the design of the sludge line
   - The ratio BOD5/TN is higher and more favourable to the biological process to remove nitrogen. This is an opportunity to optimise the biological reactors; they can handle higher biological loads and the digested sludge returns.

     As a result of such rations the structure of the biological tanks, after the primary sedimentation in the water line, has been modified.

2- The sludge dewatering :
   - The new plant will present a very important capacity of treatment, disserving more than 5million inhabitants, which is one of the biggest plant in Middle East. The corresponding sludge production is very consequent too (up to 218 T/day of fresh sludge) and deserves a modern mechanical dewatering to facilitate its operation and handling.

     Therefore a mechanical dewatering of the digested sludge by band filters had been selected instead the centrifuge dewatering existing in phase I.

3- The biogas sulphurs removal:
   - Considering the very high concentration of sulphurs present in the biogas dedicated to the cogeneration, the technology has been changed the; nevertheless it is still be a biological treatment.

Furthermore, the odour emissions of the plant are treated and the noise emission is prevented.

One of the major concerns was the reliable operability of the installation. In that perspective, the chosen design make possible to treat the design flow having at least one step of treatment out of operation: the chosen configuration brings more flexibility in operation and allows a fast adaptation to the inlet wastewater characteristics.

This expansion (phase II) is using the same performing process (primary clarifiers, biological tanks etc.) of the existing plant in order to ease its operation and control.

The final plant presents the same treatment steps than phase I:

- Primary settling,
- Biological treatment and clarification,
- Disinfection by chlorination,
- Energy recovery (on treated water),
- Primary and biological sludge thickening,
- Sludge digestion and biogas energy recovery,
- Digested sludge storage,
- Ventilation and odour control of the plant,
- Dewatering.

This section, will only present and discuss the design modifications of Phase II with respect to phase I, as the study of design alternatives for phase I is out of the scope of this study (to check phase I project design alternatives refer to phase I project design documentation).

Biological treatment

The decanted water flows to the repartition structure of biological tanks.

There are eight biological tanks for the phase I and 3 additional tanks will be built for the phase II. Each tank can be isolated from the repartition chamber with the use of stop logs.

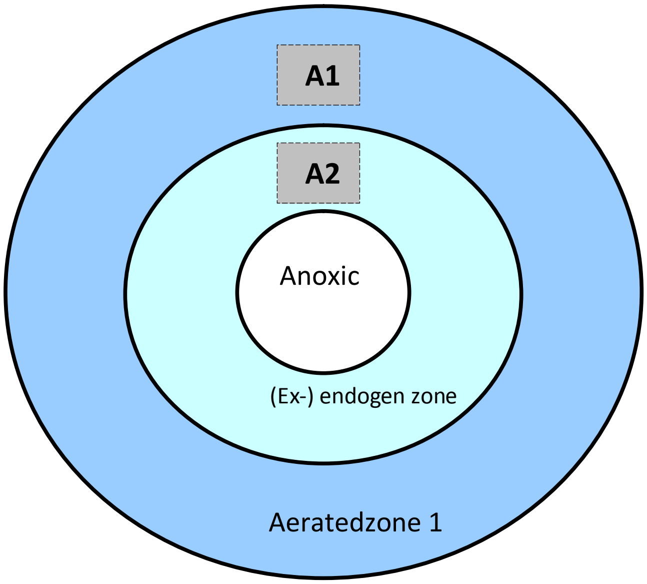
For the phase I, each biological tank presented a ‘trizone’ configuration (anoxic, aeration and endogen zones). Due to a BOD5/TKN ratio better than expected, the design has been modified to a ′bizone’ configuration (anoxic and 2 aerated zones). Phase I tanks will be upgraded to this configuration.

Indeed, the higher loads to treat require an increase of the aeration capacity of each tank, especially during winter season in A2.

Furthermore feed backs from other plants have proven that an endogen zone is not necessary anymore in hot water. A well aerated activated sludge presents better settling qualities at the clarification step.

This configuration leads to optimize the number of structure required for the phase IIa. Therefore the ex-endogen zone, now A2 will be equipped with additional air diffusers.

For the phase IIa, there will be 3 additional biological tanks with the ‘2 zones’ configuration. The tank configuration (for phase I and IIa) is illustrated hereafter

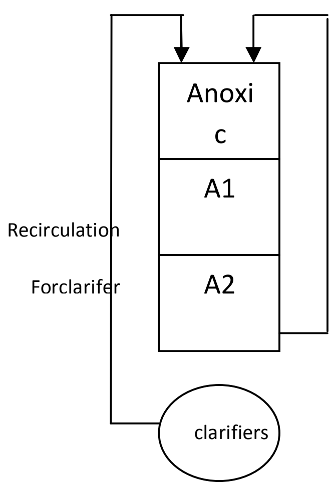


Each of the 11 reactors will have the following design:

- T Total Volume: 26,200 m^3
- T Water depth: 8 m
- T Internal diameter: 33.1 m
- T Volume of anoxic zone: 6,875 m^3
- T Volume of aerated zone: 19,325 m^3
- Total biological volume for the 11 reactors: 288,200 m^3

<u>Mixed liquor recirculation and mixing</u>

The localization of the recirculation and their rates are illustrated hereafter:



In order to bring nitrate formed in aerated zone to the anoxic zone for denitrification, mixed liquor pumps will recycled the activated sludge from aerated zone to the anoxic zone. The percentage of recirculation is 165 to 305% of the ADWF.

There are 4 duty pumps installed per aeration tank and one standby by in store, their capacity is1,100 m^3/hr.

For the existing line (phase I), in order to reach 305% of the ADWF in the recirculation (consequence of the adaptation of the tanks), it will be added a new recirculation pump (1,100m^3/hr.) located in the endogenous zone (A2) of each biological tank. This flow is sent in the anoxic zone like the actual recirculation flow.

Also for each tank, the maximum recirculation flow is about 4*1,100 = 4,400m^3/hr.

Mixing is achieved by means of four submersible agitators per anoxic zone and four submersible agitators per second aerated zone A2. A1 has no mixers since it is air mixed.

The agitators and the recycle pumps are accessible for maintenance thanks to jib cranes installed on the top of the biological tanks.

<u>Filamentous bacteria</u>

According to the feedback of the plant operation, it can occur a development of bacterium, filamentous type.

To avoid this problem, it has been chosen the installation a chlorinated water injection system on each biological tank.

This system is an injection pipe installed in the aerated zone near the exit of the treated water (before degassing tank). The chlorinated water is not injected all the time: just during the periods when the filamentous bacteria appear in the biological tank.

Digested sludge dewatering

The digested sludge will be dewatered by mean of belt filter press. This mechanical dewatering step is new therefore the whole system (phase I +phase II) has been considered for the design of this step.

The press band filters have been chosen as the best alternative given the requested dryness according to MWI specifications (either 20% or 18%): they allow to reach such dryness easily with a low polymer consumption rate (much lower than with a centrifuge system). Hence, it was selected as the best option to minimize CAPEX and OPEX. In addition, as the DS concentration will be much higher than for phase I (which is 3%) proliferation of flies will be reduced drastically (being stated as one of the most important problems for the inhabitants of the surrounding zones).

Besides, for a WWTP of the same size than As-Samra the drying bed solution is not the best adapted. Indeed, Liquid bed drying is an extensive technology, thus in order to reduce the space required to the dewatering, a mechanical system has been considered.

The design parameters are the following:

Design loads (for the maximum loaded day):
- Running: 24 h/day, 7 days per week
- Sludge design load: 234.4 T/day or 9,8 T/h
- Inlet concentration: 32 g/L
- Specific design mass load: 245 kg of DS/m.h
- Total required length of belt: 39.9 m
- Sludge volume: 7,285 m3/day or 304 m^3/hr
- Specific design hydraulic load: 10 m^3/m.h
- Total required length of belt: 30.4 m

Belt filter press characteristics:
- Unit band width: 3 m
- Required number of units: 14 units
- Capture rate: 93%
- Outlet concentration: 20%
- Design outlet sludge load: ~ 218 T/day
- Design outlet sludge volume: 1,090 m3/day or 45 m3/h
- Final number of belt filters: 14 duty +2 standby

The digested sludge pumping station is equipped with 14 duty +2 standby progressive cavity pumpsof 20 m^3/h unit capacities.

Sludge returns:
- Returns load: 16.4 T/day

Chemical dosing:
- Polymer dosing: 5 kg of active matters/T of Dry solids

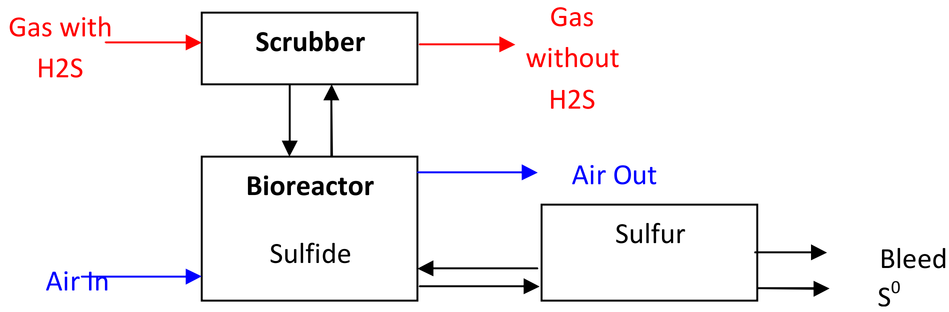
There will be four installation of powder polymer dosing for the belt filters press.

Washing:
The washing is carried out thanks to 7 bar pressurized service water.

Biogas sulphurs removal

It has been foreseen a biological removal of the sulphur content of the biogas by a different process from the existing one. The gas enters a wet packed column scrubber and is desulphurised with a slightly alkaline fluid. The cleaned gas leaves the scrubber at the top.

The process includes three sections: a scrubber, a biological reactor and a sulphur settler. As illustrated in the diagram hereafter:



The spent scrubber liquid is collected at the bottom of the scrubber and directed to the bioreactor. In the reactor air is dispersed at the bottom in order to enable the biomass to convert the dissolved sulphide into elemental sulphur, thereby regenerating caustic soda. The sulphur is separated as a solid and the liquor is returned into the reactor.

The regenerated bioreactor effluent is recycled to the scrubber for new removal of H2S.