Arantza Figueredo and Juan Ignacio Tomico.
afigueredo@giahsa.com

1. INTRODUCTION

Giahsa, the operating company of the Service Association of Municipalities in the province of Huelva (MAS) consisting of 70 municipalities in a wide geographic area, it provides (apart from the integrated water cycle) other services such as collection of wastewater from customer's homes, treatment and then disposal within the best health and environmental conditions. This public company manages, therefore, the treatment of wastewater from almost all municipalities in the province of Huelva -70 out of 79 -, scattered over 10,000 square kilometres in completely different weather conditions and geographical altitudes. Moreover, Huelva is characterized by locating a total of 23 environmentally protected areas, among which is the *Doñana* National Park (UNESCO World Heritage) and *Sierra de Aracena y Picos de Aroche* Natural Park. The efforts made after decades of hard work have managed to make decentralization of plants a reality thanks to an excellent service.

Apart from collecting water previously used whether by people in their daily life or by industries for their production processes – MAS – a public company owned by councils, is also responsible for converting this wastewater into clean water to be discharged back to public waterways or to be reused for different purposes. It must be said that the natural environment of the province enjoys maximum protection and requires a careful respect. This management includes the production of treated water (use and control of plants, corrective and preventive maintenance of plants, and processes of treatment and adaptation to the environment).

Thus, facilities used for sewage and water treatment consist of miles of sanitary sewers and hundreds of water treatment plants, and these are grouped into five distinct areas under the authority of four Associations of Municipalities (See Table 1).

Administering sewage treatment plants in geographical areas with a high number of small towns, that are widely set apart, makes imperative to optimize the budget in terms of production and maintenance by the companies involved in the work. Such an approach lends itself to the integral viability of the company without the need to incur a negative effect on consumer prices in areas like this, with a low economic development rate.

Similarly, it is vital and indispensable to assure quality of service, in terms of both upholding everyday living standards for users of the service and to sustain environmental standards by complying with current legislation.

Consequently, GIAHSA has taken the decision to install a telecontrol system and Scada Automation Software for controlling the equipment and working of our installations. This will make it possible to optimize budgetary resources destined for personnel and energy. Installations are classified in terms of how many there are in a given area, thus each area has of a number of operators who make daily visits to installations to carry out equipment control, maintenance and cleaning tasks.

The working procedures of the distinct sewage processing plants are controlled from the central terminal using Scada i-Fix Dynamics program, which makes it possible to designate parameters for the work that needs to be done and to closely monitor each autonomous component of the equipment involved in every process.

We have chosen the Ayamonte Subsystem to illustrate the telecontrol system used by the company, and EDAR Ayamonte to provide a representation of the biological sewage process and to include an overview of how the program can be used to control the whole process.

Associations of Municipalities	Coast of Huelva	Coast Area	- 4 WWTPs, 42 associated pumping - WWTPs in *Esury Coast* in situation of implementation and starting.
		Huelva Area	- 6 WWTPs , 64 associated pumping
	Andévalo and Coal-Mining Area	- 9 WWTPs, 3 associated pumping	
	Ribera de Huelva (Waterfront)	- 11 WWTPs, 5 associated pumping	
	Sierra Occidental (West Area) and Sierra Minera (Coal-Mining Countryside).	- 16 WWTPs, 7 associated pumping	
	County	- 9 WWTPs, 15 associated pumping	
Network of sanitary sewers	Network length: 1.354.985 m.		

Table 1. Summary of decentralized plants managed through a centralized remote-control.

2. TELECONTROL SYSTEM DESCRIPTION

We put into place a telecontrol system based on PLC-SCADA technology that interconnects with a communications system capable of meeting the conditions required for providing information in real time.

The investment has resulted in a system located in the GIAHSA Main Control Centre that covers approximately 130 installations within a radius of between 5 and 100 kilometres from the Centre and provides up to 16,000 physical and 58,000 variable signals that can be monitored 24 hours a day by one single operator.

In order to achieve thoroughness there is a set of functions in place, such as prioritized alarms on different levels and warning systems that can effectively draw the supervisor's attention in the event of system failure thus avoiding the likelihood of a reduction in the quality of the service.

The Main Control Centre connects to Secondary Control Centres (located in every sewage plant) through the main network (based on microwave links on a 15.5 GHz).
The secondary network (which works with UHF radio frequencies) connects each Ebar to a sewage plant, to obtain satisfactory refresh functions in terms of the aforementioned principles.

Each remotely telecontrolled plant has a programmable automaton, or a network of them, containing the rules and algorhythms required to make it/them function. These react to certain discreet signals or deviations from pre-established control range parameters.

The Ayamonte Sewage Processing Plant has an automaton network of seven PLCs (one master and six slaves) that are located in different areas of the plant and control the specific processes in each of these areas.

The master PLC acts as a bridge between the other PLCs and the communications network. This particular configuration makes it possible to override the control functions on each separate PLC, consequently bypassing local control.

Finally, it is worth emphasizing that in the event of failure of the EDAR PLCs, the processes can be governed directly from the Engine Control Centres (by a cable network), which complies with the standards required to keep the equipment functioning correctly.

However, it's necessary established again teh kind of comunications system in CountrySide Area, because of the orography, the side of populations and treatment plants.

To introduce the same Comunications Wet there is in the Coast, needs of great investments, because of the points described in the other paragraph. In this sense, we are proving, in several facilities, another control suystema, depending on Comercial Comunications Wet (Mobil Telephony), stablishing conection between local systems and control center, through gprs system.

We can control the facilities, without depending on continuos conection, designing local plc´s locales with enough capacity to store al of data, on the other hand, we can parametrize the information in order to obtain stored data and to solve different problems in relation to processes and facilities.

Data Capture to control teh processes and maintenance, is starting doing, in teh coast too, through an special program, using las Blackberrys like Capture Data System, that will be loaded in Managment PCs and our Control Data Center, through gprs System.

This system is called like: BLACK BERRY – MAXIMO and has teh next advantages in relation to the paper:

- It's not necessary to movement to load the data.
- To allow to get data in the same moment to obtain them.
- Its possible to capture the previous data, stored, and to calculate indirect and direct variables and to contro mistakes.
- Creating and Receiving e-mails with information that we can receive (processes control, problems, maintenance, work points etc...)

3. *EDAR* – SEWAGE PROCESS CONTROL PARAMETERS

EDAR was designed to cope with a population of 25,000 in low season and 50,000 in the high season. In actual fact, it caters for an average of 38,000 equiv-inhabitants and a mean flow of 5,000 to 8,000 cubic metres, depending on the time of year, given its tourist zone status. It is based on a Prolonged Aeration Process, with two Wastewater Treatment Ways, which incorporate a Nitrogen Removal System.

The control parameters are determined by: (1) the amount of culture that is present in the two (anoxic and aerated) biological reactor zones; (2) the quality of the culture in terms of how old the sludge is; (3) the concentration of dissolved oxygen in the biological reactor; (4) the concentration of sludge inside the decanter, and (5) the method of moving the active biomass through the recirculation process (normal and denitrification) and the extraction of excess sludge.

4. EQUIPMENT AND HOW THE INSTALLATION WORKS

In order to control the aforementioned parameters a number of gauges is set up in series in different areas of the installation and the signals emanating from them make it possible to monitor these distinct parameters continuously and autonomously. There are two gauges deployed for total solids, one in each of the reactor zones (anoxic and aerated), and their signals provide an indirect reading of the progress of the culture in each chamber. Similarly, a dissolved oxygen concentration gauge is placed inside the aerated reactor zone, as well as a gauge to measure accumulated sludge percentages in the decanter. Finally, PH and Suspended Solids gauges have also been deployed in both zones, which help to control inlet and outlet water flow from the EDAR.

The programme has the task of controlling and administering the installation and it is set up with this remit in mind as well as for optimizing energy consumption and effectiveness in all related processes.

In keeping with this, the programme has been designed to establish minimum and maximum limits of suspended solids in the oxic and anoxic chambers. The settings for the anoxic chamber regulate the sludge that recirculates through the reactor with the aim of eliminating nitrates from the biological sludge of all the biomass that passes through it. Between the minimum and maximum settings there are only 25 units of difference, so that the culture in the smaller chamber does not get washed where the wastewater and recirculation inlets converge. Consequently, when the solids gauge detects the minimum setting it means that the sludge requires recirculating in the chamber and, conversely, when the maximum setting is reached it stops the recirculation. These 25 degrees of difference determine the situation so that there is continuous, albeit not sustained, recycling.

When the reactor requests recirculation the first thing that needs to be done is ascertain whether the decanter has accumulated any sludge, as the objective here is to optimize the flow of active biomass through the water and sludge pipe with the least energy consumption possible. To this end, there is a minimum and a maximum

setting established so that the equipment that monitors the concentration of sludge stored inside the decanter can send out a reading. If the decanter senses a lower percentage than the established minimum it impedes the movement of sludge and then allows it to build up again until it reaches maximum (and/or removes excess sludge), following which it works in the other direction until the minimum setting is reached again. When the percentage of sludge is appropriate and the active biomass circulation commences a rapid response PIC valve opens allowing dense consistency sludge from the decanter to pass through the outlet section where it then gets recirculated or removed. The amount of sludge that is subject to recirculation is determined by the amount of solids in the reactor, by the concentration of sludge for the decanter, the time it has been working and the stoppage time of the pumps designated for the task, which in conjunction govern the speed with which the outlet sections are emptied.

On the other hand, the aerated reactor has two value settings that allow it to decide whether to let in the recirculating sludge to this part of the system or whether to remove excess sludge. Given that the sludge ought to recirculate round the anoxic chamber the aerated zone of the reactor controls the removal of excess sludge. Consequently, the setting is normally lower than the corresponding quantity of suspended solids and the reactor controls the removal of sludge within logical working parameters. It was discovered that by letting the recirculation and excess sludge removal functions coincide it was possible to control the microbiological process more closely and to give the sludge maximum shelf life for its active and change assimilation possibilities while requiring only minimum productivity. The quantity of sludge removed from the system is determined by the stop and start times of the excess sludge pumps.

In order to control the denitrification pump a maximum setting is specified for the anoxic chamber which is set at 10 units above the previous average reading so that when the level of solids reaches that average the denitrification pump kicks in until the solids reading itself reaches the set maximum.

The turbines are also controlled automatically, which helps with the energy consumption of the installation. Another two settings are specified for this situation - a maximum and a minimum, in keeping with the levels of dissolved oxygen that the reactor needs to maintain. It is achieved by starting the turbines when dissolved oxygen levels reach the set minimum and stopping them when the level reaches the set maximum.

By way of summarising, the actual EDAR working parameters are: (1) Suspended solids in anoxic chamber = 1,750-1,775-1,785 ppm (2) Suspended solids in aerated chamber = set to 1,500 to 1,700 ppm, and keeping average levels to 1,939 ppm. Percentage of sludge in decanter = set to 2 to 10 percent. (3) Start-Stop times for recirculation pumps = 55:5. Start-Stop times for excess sludge pumps = 9:15. (4) Average sludge age = 11 days. Mass load = 0.10. (5) Oxygen Levels = 1.5 –2.5 ppm.