TOTAL WATER SOLUTION PROVIDER
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INTRODUCTION

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2. ENNISKILLEN WWTP, United Kingdom
3. CEBU CFB Power Plant, Philippines
Growing population, rapid urbanization and industrialization have made natural sources of quality water for potable and industrial use increasingly scarce globally. Contamination of water resources and more stringent discharge regulations demand more advanced and cost-effective water treatment technology. One increasingly popular alternative is to recycle treated wastewater. In many cases, the cost of treating wastewater for reuse or recycling is less than other methods of production with the added advantage of conserving precious water resources.

Doosan Heavy Industries & Construction along with two subsidiaries, Doosan Enpure in the UK and Doosan Hydro Technology in the US, can provide solutions in a wide range of water and wastewater treatment & reclamation, both in the public and private sectors. We offer tailor-made solutions to pinpoint your needs through our engineering capabilities and experience. In addition to the conventional processes, we can provide state-of-the-art water treatment processes, such as membrane-based technology and advanced oxidation process, as part of integrated solutions, ensuring a cost-effective benefit to the client.

We are ready to serve industrial sector clients to handle water supply, treatment and recycle issues combining our proven desalination technologies and experience with conventional technologies. In addition, a full range of delivery options, EP, EPC, DBO, and BOT, are available to meet your needs.
WATER AND WASTEWATER TREATMENT PLANTS

BUSINESS AREAS

- WATER TREATMENT / 07
  - Drinking Water
  - Industrial Water

- WASTEWATER TREATMENT / 10
  - Municipal Wastewater
  - Industrial Wastewater

- SLUDGE TREATMENT & ENERGY RECOVERY / 14

- ZERO LIQUID DISCHARGE / 15
General

Conventionally, the main purpose of water treatment is to remove solids, turbidity and pathogenic micro-organisms. Recently, however, to reduce the risk to public health, more and more countries are introducing new drinking water regulations containing stricter limits on pathogens and naturally occurring compounds.

Doosan Heavy Industries & Construction provides optimized solutions from conventional systems, which consist of coagulation & flocculation, sedimentation, media filtration, and disinfection, to state-of-the-art technology such as membrane-based or advanced oxidation process (AOP). In addition, Doosan provides effective intake systems and distribution networks in order to provide high quality drinking water every single day.

Highlighted Project

Elvington Water Treatment Plant
- **Client**: Yorkshire Water, UK
- **Capacity**: 270,000 m$^3$/d
- **Contract value**: £10 Million
- **Process selection**:
  - Coagulation-flocculation
  - Sedimentation
  - Sand filter
  - AOP (Ozone) system
  - GAC
  - Disinfection

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*Engineering work and main equipment provision only

Note:
- DAF: Dissolved Air Floatation
- DMF: Dual Media Filtration
- UF: Ultra Filtration
- GAC: Granular Activated Carbon
- RO: Reverse Osmosis
GENERAL

Inevitably, most industries need water resources. More technologically intensive industries require larger quantities of higher quality water.

Quantity and quality of water become a key factor influencing all stages from plant operations to shut-downs in industries.

Doosan Heavy Industries & Construction provides cost-effective and reliable industrial water supply systems for all kinds of water resources to achieve stable manufacturing and plant operations in industries including power plants, petrochemical & oil refinery, semiconductors, beverage, and pharmaceuticals.

HIGHLIGHTED PROJECT

Cebu CFB Demineralization Plant

- **Client**: Kepco SPC Power Corporation
- **Capacity**: 2,880 m³/d
- **Contract value**: $4.9 Million
- **Process selection**:
  - Seawater Intake Facility (Screen)
  - Auto Strainer + UF
  - SWRO + BWRO
  - EDI
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**Abbreviations:**
- **RO:** Reverse Osmosis
- **CPP:** Condensate Polishing Plant
- **UF:** Ultra Filtration
- **CCPP:** Combined Cycle Power Plant
- **TPP:** Thermal Power Plant
- **NGPP:** Natural Gas-fired Power Plant
- **NPP:** Nuclear Power Plant
WASTEWATER TREATMENT PLANTS
MUNICIPAL WASTEWATER TREATMENT AND REUSE

General

National and local governments are spending vast sums to expand and improve their wastewater treatment infrastructure. They are faced with daily challenges to meet the increased demand caused by growing populations, more stringent regulations, dwindling traditional water supplies and aging equipment.

Depending upon geography, climate, food style and sewage network systems, each municipal wastewater treatment system has unique characteristics and diurnal & seasonal patterns. Thus, in order to provide an adequate solution, the supplier or contractor should have diverse experience. Doosan Heavy Industries & Construction has completed municipal wastewater treatment projects in East Asia, Europe, the Middle East, North Africa and North America giving us experience in a wide range of scenarios.

With our high technological capacity, we create optimized solutions, converting conventional treatment methods such as oxidation ditch into a water reuse system through MBR and RO. In addition, we can provide sewage systems and treated effluent network systems with pumping stations.

Highlighted Project

Luggage Point Wastewater Treatment Plant

- **Client**: Brisbane Water, Australia
- **Capacity**: 216,000 m³/d
- **Contract value**: $18 Million
- **Process selection**:
  - Screen/Grit removal
  - Primary clarifier
  - Activated sludge system (BNR)
  - Secondary clarifier
  - DAF thickening-dewatering
  - Odor control
## Major References

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BNR: Biological Nutrient Removal  
CAS: Conventional Activate Sludge  
SBR: Sequencing Batch Reactor  
MBBR: Moving Bed Bio Reactor  
MBR: Membrane Bio Reactor  
DAF: Dissolved Air Floatation  
BAFF: Biological Aerated Flooded Filter  
UF: Ultra Filtration  
RO: Reverse Osmosis
WASTEWATER TREATMENT PLANTS
INDUSTRIAL WASTEWATER TREATMENT AND REUSE

General

Despite recent trends in the developed world to minimize wastewater production or increase recycling, many industries remain dependent on processes that produce wastewater.

Unlike municipal wastewater, industrial wastewater may contain a number of toxic materials depending on the industry. Although some materials can be removed by simple treatment processes, generally, a combination of physical, chemical and biological treatment processes need to be applied.

Doosan Heavy Industries & Construction has a variety of experiences in developing wastewater systems for SWRO desalination and power plants. In addition, we are currently constructing a ZLD system for the petrochemical wastewater treatment project, SEP U&O in Saudi Arabia.

Highlighted Project

Jeddah Ph.3 SWRO Desalination Plant WWTP
- **Client**: Saline Water Conversion Corporation (SWCC), KSA
- **Capacity**: 25,392 m³/d
- **Process selection**:
  - Rectangular sedimentation
  - Sludge dewatering (Centrifuge decanter)
  - Sludge dryer

Jebel Ali M Power Plant WWTP
- **Client**: Dubai Electricity & Water Authority (DEWA), UAE
- **Capacity**: 400 m³/d
- **Process selection**:
  - Rectangular sedimentation
  - Sludge dewatering (Centrifuge decanter)
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**Abbreviations**
- **SWRO**: Seawater Reverse Osmosis
- **CCPP**: Combined Cycle Power Plant
- **TPP**: Thermal Power Plant
Sludge treatment has traditionally focused only on dewatering to minimize the mass of wet solids for disposal. Increasingly, legislation requires sludge to meet minimum standards for hygiene and toxicity. Additionally, the organic content of the sludge is seen as a resource, in particular as a feedstock for anaerobic digestion, providing biogas for power generation and heat to run the process.

Doosan Heavy Industries & Construction can provide a wide range of sludge treatment processes to meet all legislative requirements as well as maximizing the return of energy and other useful components of the sludge stream. These systems include thermal and sonic pre-treatment, pasteurization, thermophilic and mesophilic digestion, dewatering and drying.

**Highlighted Project**

**Ringsend Sludge Treatment Plant Extension**
- **Client**: CAW for Dublin Council, Republic of Ireland
- **Capacity**: 120 t dry-solid/d
- **Process selection**:
  - Drum thickener
  - Centrifuge thickener
  - Anaerobic digester with tube mixer
  - Two belt thickener / Press
  - Thermal Hydrolysis

**Major References**

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*TTHP*: Thermal Hydrolysis Process  
*AD*: Anaerobic Digestion  
*SD*: Sludge Drying  
*Past*: Sludge Pasteurisation  
*SONIX*: Sludge Sonification  
*CHP*: Combined Heat and Power
ZERO LIQUID DISCHARGE SYSTEM

General

Zero liquid discharge (ZLD) is the most advanced wastewater treatment technology currently available. It can achieve no or minimized effluent and highly purified recycled water. The ZLD system is applied for limited wastewater fields which are small and can be hard to treat using conventional treatment systems and in water-demanding industries, such as refineries, petrochemical plants, IGCC and FGD power plants. Recently, due to increasing focus on environmental and social issues as well as cost effectiveness, the ZLD system has been expanding to an increasing number of usages.

Generally, the ZLD system is based on high pressure reverse osmosis (RO) or thermal evaporation technology. Each ZLD system is designed to meet the site-specific needs and combines a number of wastewater treatment technologies including lime softening, biological treatment, MF/UF, and evaporation ponds.

Doosan Heavy Industries & Construction is currently leading the high-capacity evaporator market, Multi-Stage Flash (MSF) and Multi-Effect Distillation (MED), and has significant experience in creating combined systems through SWRO and municipal & industrial wastewater treatment projects.

Currently, our 120 m$^3$/d capacity pilot plant is fully operational, and we are in the process of scaling up to 1 MIGD (4,546 m$^3$/d) capacity.

Highlighted Project

ZLD System Pilot Plant

- **Location**: Changwon, Korea
- **Capacity**: 120 m$^3$/d
- **Process selection**:
  - Mechanical Vapor Compression Falling Film Evaporator
  - Thermal Vapor Compression Falling Film Evaporator
  - Forced Circulation Crystallizer
Doosan actively conducts its water-related research and development activities at its four dedicated R&D centres in Changwon, Korea; Dammam, KSA; Tampa, Florida, USA; and Birmingham, UK. The main goal of our R&D centers is to create and launch needs-driven water systems that will introduce brand-new solutions to the water market. Main R&D topics include:

- High-efficiency RO Pretreatment System
- Large-capacity RO train (8 MIGD) utilizing 16-inch RO membranes
- High-efficiency Dissolved Air Floatation (DAF) System
- Bio-fouling & Scale control
- High-temperature & High-efficiency MSF/MED
- High-efficiency Membrane Bioreactor (MBR) System
- Energy-efficient Zero Liquid Discharge (ZLD) System
- Concentrated Solar Power (CSP) Desalination
The UK-based subsidiary Doosan Enpure is a process engineering company with proven design, technology and project delivery credentials in the water and wastewater treatment sectors.

Doosan’s water treatment business provides a full range of services for water and wastewater treatment: engineering, procurement, construction as well as operation and maintenance. Through our accumulated know-how in membrane technologies and EPC experiences around the globe, we offer differentiated solutions to satisfy clients’ various needs.

- **Advanced Water Treatment**
  - Advanced water treatment solutions including membrane technologies and also in-house technologies such as Dissolved Air Flotation (DAF)

- **Municipal Wastewater Treatment and Reclamation**
  - Advanced treatment & reclamation solutions including media and membrane filtration
  - Biological Nutrient Removal (BNR) process
  - Membrane Bioreactor (MBR) process
  - Pasteurisation (Puriser) process - anaerobic digestion

- **Industrial Water & Wastewater Treatment**
  - Pre-treatment and wastewater treatment systems for RO desalination plants
  - Water supply and wastewater treatment systems for power plants
  - Produced water treatment solutions for the oil & gas industry
  - Zero Liquid Discharge (ZLD) system
WATER AND WASTEWATER TREATMENT PLANTS
CASE STUDIES

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CASE STUDY: Barrow Water Treatment Plant

- **Client**: Bristol Water plc / UK
- **Capacity**: 120,000 m³/d
- **Contract Value**: £15.4 Million
- **Scope**: Low lift pumps, ozonation, flotation, RGF's sludge thickening
- **Contract Completion**: October 2004

**General**

Barrow is a large potable water treatment works, which is fed with raw water from the three storage reservoirs at Barrow. The reservoirs designated reservoirs 1, 2 & 3 receive water via Notting Hill gauge tank via Chew & Blagdon surface reservoirs and the Mendip Springs. The proportions of flow from each of these sources can be selected by the operators and therefore the quality of raw water entering the three reservoirs at Barrow can be controlled to achieve the best raw water quality within the constraint of the system. The existing treatment at Barrow consisted of microstrainers, slow sand filters complete with washing plant, chlorine contact tank & high lift pumps. Doosan Enpure undertook construction of a pre-treatment plant prior to the existing slow sand filters to alleviate problems associated with poor water quality.

**Process Description**

As per Bristol Water’s request a compliant scheme was tendered for, however after reviewing the raw water data available it was concluded that during periods of very high algal blooms the RGFs proposed as part of the compliant scheme were unprotected and would ultimately be unable to cope with the load and seal. We also quoted an alternative bid that was eventually taken up by Bristol Water which included a flotation process before the RGFs to protect the filters from the algae loadings. This system was based on the DAFrapide integrated design approach developed from the conventional flotation system offered by ENPURE for a number of years. Six No. streams complete with flocculation followed by ten No. RGFs. The pre-treatment process for Barrow WTW is a low lift pumping station incorporating duty, standby variable speed pumps, inlet works, ozonation including contact tank, flashmixing prior to the flocculation and flotation stage, and then RGFs. Dirty backwash water from the RGFs gravitates down to three dirty washwater recovery tanks where the sludge is settled and transferred to the sludge treatment process and clean supernatant is returned either to the reservoir or the inlet works. The sludge thickening stage includes WRc thickeners, polymer dosing, holding tanks and belt press.

**Conclusion**

Initial flows through the plant took place on May 20, 2004, and the quality of the treated water has continued to comply with the contractual requirements. A formal 28 take-over test was carried out during October 2004, and the treated water guarantees were all met. This was a challenging project, with the client being fully satisfied with the final quality of the DAF/ RGF installation and the treated outcomes being achieved at Barrow.
CASE STUDY: Lowestoft Wastewater Treatment Plant

- **Client**: Anglian Water Services Ltd. / UK

- **Capacity**: 60,000 m³/d

- **Contract Value**: £75 Million

- **Scope**: Flagship new build sewage treatment works for Lowestoft / Scope includes supply, construction, installation, commissioning and operations, including new preliminary, primary, secondary and sludge treatment facilities (with dedicated industrial waste stream treatment)

- **Contract Completion**: January 2002

**General**

Anglian Water Services Limited awarded Doosan Enpure part of the £75 million main contract for work at Lowestoft Wastewater Treatment Works in Suffolk. The purpose of the Project was to provide treatment facilities for the major conurbations in the catchment area including Lowestoft, Pleasurewood, Corton, Blundeston and the industrial arisings from BirdsEye Walls and SFS. The Doosan Enpure scope comprised new preliminary, primary, secondary and sludge treatment facilities and includes supply, construction, installation, commissioning and operation of the plant for one year post project completion. There had been extreme public concern in the area providing many challenges to overcome. The decision was made to provide a fully enclosed works with state of the art odour control facilities incorporating double and triple containment.

**Process Description**

The focus of the design was on environmental sustainability including water reuse with provision of MBR’s for high quality wash water and irrigation use, OPEX savings from purchase of high speed turbo blowers, sludge recycling with the production of a Class A product allowing safe disposal route to land, CHP generation utilising biogas for gas engines, and sludge minimisation with the provision of helical spiral separators and thermophilic digestion. Many novel processes have been incorporated into the highly innovative Lowestoft design, which include Primary lamella Plant, Re-Aeration (60% flows), Kaldnes DAF (1/5th flows), MBR (1/5th flows), Industrial Treatment, Sludge Treatment, Odour Control and CHP. The design was based on 267,000 PE / 16,000 kg BOD, 267,000 PE / 16,000 kg BOD.d Industrial Load, 138,000 PE / 8,327 kg BOD.d Domestic Load, Flows are Min 290 l/s, Avg 382 l/s, Max 700 l/s. The area of the dome covers 14,200 m² equivalent to 1 ½ hectares and the area of the site as a whole is 134,000 m² or 14 hectares. 14,000 m³ of concrete was used during construction and 120 km of cabling installed.

**Conclusion**

Lowestoft WWTP is a perfect example of innovative technology being applied in an environmentally sustainable way. It is anticipated to be an excellent reference site for key processes currently being developed for future waste water treatment technology. The Works is unique in that novel technologies developed have been provided under one roof allowing designs to be demonstrated as well as operational ability, to future clients. The project also allows different processes to be challenged under controlled load and flow variations beyond normal design, which in turn will improve competitiveness.
**CASE STUDY: Moa Point Wastewater Treatment Plant**

**Client:** Wellington City Council / New Zealand  
**Capacity:** 345,600 m³/d  
**Contract Value:** NZ$149 Million  
**Scope:** Design, build and operate  
**Contract Completion:** October 1998

**General**  
Wastewater treatment for the 250,000 citizens of Wellington, New Zealand’s capital city, originally consisted of preliminary treatment using screens, followed by discharge straight into the sea. Through Anglian Water International, Doosan Enpure was involved in the NZ$149 million contract to design, build and operate state-of-the-art treatment works at Moa Point - close to the airport - and a smaller plant serving the suburb of Karori for Wellington City Council. Anglian Water is operating the facilities for 21 years.

The project became fully operational in October 1998 and comprises the design, construction, commissioning and operation of:
- a small, self-contained treatment plant at Karori (10,000 pe);
- the main treatment plant at Moa Point (240,000 pe), located alongside Wellington Airport;
- a 1.8 km outfall pipe into Cook Strait;
- a twin sludge pipeline extending some 8.7 km through several suburbs and native bush reserves to a treatment plant located at Careys Gully.

**Process Description**  
Sewage flows up to 4000 l/sec are pumped to the plant inlet works utilising 10 250kw submersible pumps. Following screening and grit removal in the inlet works, the flow passes through lamella plate separators, removing around 60% solids. Secondary treatment uses Kaldnes suspended carriers enabling us to develop a low profile, compact design. This is followed by the solids contact/reaeration process which ensures a high degree of process flexibility and robustness. The plant is within enclosed buildings with all the foul air removed via an odour control plant. The odorous gases are chemically scrubbed in three stages. Three secondary clarifiers - 42m in diameter - precede the final disinfection treatment carried out using ultra-violet light treatment. This reduces the final faecal coliform count to less than 200 fc/100ml. The plant is highly automated.

**Conclusion**  
The DBO (design, build and operate) structure of the contract - known as Clearwater Wellington - brings significant advantages to the client. Risks are transferred from the Council to the contractor, and there are performance guarantees in place. The council retains ownership of the asset, while AWI is responsible for operating the plant to the prescribed standards during a 21-year period. The contractor has a natural incentive to design and build an efficient, high quality works to deliver optimum lifetime cost. Anglian Water has arranged project financing for the construction in conjunction with Wellington City Council through bonds sold to institutional investors.
CASE STUDY: Avlon Wastewater Treatment Plant

- **Client**: AstraZeneca
- **Capacity**: 2500 m³/day
- **Contract Value**: £19.4 Million
- **Scope**: Design, supply, erection and commissioning
- **Contract Completion**: March 2006

**General**

This scheme provides full preliminary and secondary treatment for wastewater arising from pharmaceutical production at the Avlon works, together with sludge treatment facilities.
- Flows up to 3000 m³/d are treated through the plant and discharged via the existing outfall to the Severn Estuary.
- Final effluent meets a treatment standard of 80% removal of soluble COD or 500 mg/l soluble COD, whichever is the greater, subject to a 50% reactor fill of Anox media and a minimum influent concentration of 1000mg/l.
- Treated sludge is exported from the site as sludge cake, for final disposal by incineration.
- Doosan Enpure took on the role of CDM Planning Supervisor and Principal Contractor and were also the designer for all process, mechanical, electrical & systems engineering.
- Civil and building services work was undertaken by Alfred McAlpine Civil Engineering, utilising Pell Frischmann as designers and Stride Treglown as Architect.

**Process Description**

Preliminary treatment: consist of:
- Coarse solids separation
- Blending and balancing
- Nutrient addition and pH balancing

Secondary Treatment consist of:
- Biological treatment utilizing Anox suspended carrier aeration process in two parallel reactor streams each comprising three reactor tanks.
- Storage of final effluent during periods of low tide

Sludge Treatment consist of:
- Treatment to remove and thicken sludge produced in preliminary and secondary treatment and to convey to skips for removal from site.

**Conclusion**

The client successfully took over the Avlon Effluent treatment plant on March 2nd, 2006. This scheme was a complex and high quality plant, working for a client who quite rightly required the very best standard of work.
CASE STUDY: Ringsend Sludge Treatment Plant Extension

- **Client**: CAW for Dublin City Council
- **Capacity**: 120t (Dry solid)/d
- **Contract Value**: €20 Million
- **Scope**: Extension of existing sludge plant, including a third stream CAMBI THP process. SAS Drum Thickeners, sludge thickening centrifuge, 4th Digester tank, SCADA and MCCs
- **Contract Completion**: October 2009

**General**

As part of Dublin City Council’s program to upgrade the Ringsend wastewater treatment plant, CAW the plant operator and Doosan Enpure were employed to provide the following services: Design, Procurement, Installation, Commissioning and Operation of an Extended Sludge Plant incorporated a new third stream CAMBI THP Sludge Plant.

The scope of work for this extension included the provision of:-
- Additional SAS Drum Thickeners with associated plant.
- Additional sludge thickening centrifuge with associated plant.
- Third stream of CAMBI THP Plant including four reactors to handle an additional 56 TDS/day of thickened sludge with associated plant and additional steam generation capacity.
- Additional 4th Digester Tank of 4,500 m$^3$ capacity, 1:1 aspect ratio with internal draft tube mixers in upward flow mode.
- Digester sludge cooling / recirculation systems.
- Associated instrumentation, electrical cabling, SCADA control and MCC’s

**Process Description**

The original Cambi 8-reactor THP plant was designed to treat 36,000 tons DS sewage sludge annually, which was after treatment digested and then dewatered and dried. The wastewater treatment plant was originally operating a two-train drum drying system of the raw primary sludge to meet the requirements of pasteurization in Ireland. The plant was extended by adding SBR biological secondary treatment reactors to the existing primary treatment plant, doubling the sludge quantity. However, by adding Cambi THP the digested cake volume was reduced and the dryer project was only expanded by 50% to cope. Also, the required digestion volume was reduced: Three 4,500 m$^3$ digesters are fed at about 6 kg VS/m$^3$/day and routinely achieve 60% VS conversion with 45,000 m$^3$ per day of biogas. The sludge plant has been extended to achieve an approximate 50% increase in capacity. To achieve this a new third CAMBI stream was added, consisting of a 4-reactor THP plant, designed to handle an additional 56 TDS/day of thickened sewage sludge. Additional equipment has also been added to the plant to accommodate the additional sludge throughput including:- three new SAS drum thickeners (making 6 in total), one new pre-THP thickening centrifuge (making 3 in total) one new 4,500m$^3$ sludge digester tank (making 4 in total) and four new digester cooling / recycle systems. To accommodate the new third stream of THP plant and the new centrifuge installation, obsolete plant had to be removed from the existing building including two belt thickener / press units, conveyors and support steelwork; redundant odour plant and the compressed air installation had to be relocated.

**Conclusion**

The introduction phase of the new plant was completed on time and to budget. The contract was conducted in an open manner with full cooperation and contributions to team solutions by all stakeholders.