Energy Production from Aerobic Granular Sludge
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Introduction
Aerobic granular sludge technology is a major breakthrough in the treatment of both industrial and municipal wastewater. Application of aerobic granules has been reported only by the late 1990s (Morgenroth et al., 1997, Beun et al., 1999, Dangcong et al., 1999), while granular sludge is well known since 1980 (Lettinga et al., 1980) in anaerobic sludge reactors. The specific feature of this technology is the agglomeration growth of bacteria in granules or pellets. The additional advantage of growing the biomass in granular shape is that aerobic granular sludge can settle fast in the reactor due to its compact and strong structure (Etterer and Wilderer, 2001). Thus, it has good settleability and a high capacity for biomass retention (Morgenroth et al., 1997). Compared to conventional activated sludge processes, the aerobic granular sludge process requires only a limited footprint (20-30% of that of a conventional plant), with clear cost advantages. Further the energy savings are approximately 30-40% more than that of conventional activated sludge systems.
Aerobic digestion has been widely used in wastewater treatment plants to reduce volatile solids content and pathogens in sludge while converting the organic matter into biogas with methane content between 55 and 70%.

Despite intensive scientific research on aerobic granular technology since about a decade, the mechanisms responsible for aerobic granulation and the strategy to expedite the formation of granular sludge, and effects of different operational and environmental factors have not yet been clearly described. Besides, anaerobic digestion of aerobic granular sludge still remains unpredictable.

This study investigates the relationship between digestibility (and so biogas production) and dewaterability in relation to the different water binding ability of the aerobic granular sludge and conventional waste activated sludge (WAS).

Methods
In this study, aerobic granular sludge was anaerobically digested. The digestion set-up consists of two sets of semi-continuous anaerobic sludge digesters (Fig 1). The digesters were run in duplo each with a volume of 9 liters. They were operated under mesophilic conditions at 37°C. Sludge residence time was adjusted to 25 days. Mixing was provided continuously by mechanical stirrers. Aerobic granular sludge (AGS) and waste activated sludge (WAS) were chosen as feed sludge. The feed sludges were collected from the pilot reactor of aerobic granular sludge and the aeration tank of the Epe Wastewater Treatment Plant located in the Netherlands.
Sludge samples were analyzed for Total Solids (TS), Suspended Solids (SS), Volatile Suspended Solids (VSS), Chemical Oxygen Demand (COD) and Ammonia Nitrogen (NH₄-N) according to Standard Methods for the Examination of Water and Wastewater...
Dewaterability was measured in terms of filterability and compactibility. Biogas compositions were analyzed by using a HP 6850 Gas Chromatograph (GC) (Carboxen 1010 plot column 30m x 0.53mm) with a thermal conductivity detector (TCD).

Results
Digestibility was determined in terms of volatile solids reduction, VS%. According to the preliminary results of the study, VS reduction of Aerobic Granular Sludge was found 63%, while that of the waste activated sludge was 51%. The produced biogas components, CH₄ and CO₂, were found as 67% and 32% for aerobic granular sludge digestion and 64% and 35% for waste activated sludge digestion, respectively.

Discussion and Conclusions
According to the preliminary results of this study, following conclusions can be drawn:

Anaerobic digestion of aerobic granular sludges and waste activated sludges produce important amount of biogas as an alternative energy derived from waste.

Anaerobic digestion of aerobic granular sludge results in a stronger VS reduction (and methane production) as compared to activated sludge grown on the same wastewater and with a similar SRT.

Recently, experimental study is continuing. The rest of the results from semi-continuous digestion experiments will be presented at the conference.

References


