Effects of Re-circulation on Sediment Properties: A Case Study in the Seaport Emden

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Introduction: To maintain nautical bottom depth at Port of Emden (Germany) re-circulation has been employed for more than three decades [1]. Utilising a trailing suction hopper dredger, fluid mud (FM) can be recirculated. During re-circulation, dredged sediment is first collected by a dredging vessel and then released back into the water creating a navigable FM layer. The main goals of this technique are to keep rheological properties, density and settling rate of FM low making the FM layers navigable [1], [2]. This study aims to investigate the effects of the re-circulation on rheological properties, consolidation and organic matter degradability, in FM to determine the most optimal frequency of port maintenance.

Methods: To investigate the effects of the re-circulation on FM properties and hence the efficiency of maintenance dredging, a number of field surveys were conducted in 2 locations of the Port of Emden. Measurements of in-situ density, in-situ rheology, acoustic measurements and oxygen saturation were carried out before and after re-circulation. Additionally, physical samples of FM were gathered from three different depths per location and analysed for rheological properties (yield stress and structural recovery), density, and organic matter degradability in the laboratory. Furthermore, settling and consolidation properties of mud were measured in order to select the most optimal frequency of port maintenance.

Results: The first findings showed that the effects of re-circulation on FM properties could be detected in-situ. Particularly, the density and the yield stress of the FM layer decreased after re-circulation by about 5% and 29%, respectively. Fig. 1 indicates the difference of field yield stress between before and after re-circulation. Fig. 2 shows that after re-circulation, the aerobic release of carbon (respiration) over time is less than in the sample before dredging. It is hypothesized that FM recirculation enhances organic matter degradation which reflects in reduced degradability of the remaining FM organic matter (sampled after dredging).

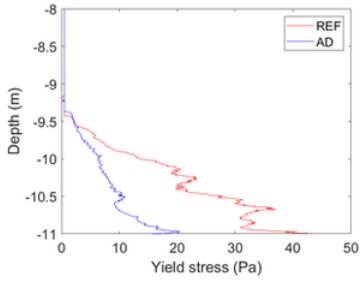

Fig. 1: FM in-situ yield stress vertical profile before (REF) and after re-circulation (AD).

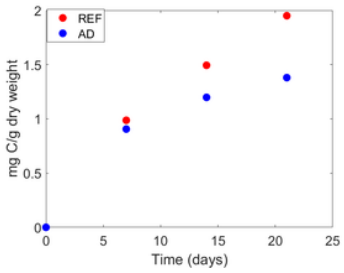

Fig. 2: Carbon released by degradation of organic matter before (REF) and after re-circulation (AD).

Summary and outlook: Different rheological characteristics and densities of the FM layers have been measured before and after re-circulation. After re-circulation, yield stresses, density and organic matter degradability of FM were reduced.
This study will support better understanding of the link between the properties of FM such as rheological properties, density, consolidation, oxygen saturation and the efficiency of port maintenance (sustainability of desired properties in terms of navigability) by means of re-circulation dredging. Thereby, the findings will aid in optimising strategies and reducing environmental impact of port maintenance.

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References: [1] Wurpts et al. (2005) Terra et Aqua 99:22-32; [2] Gebert et al. (2022) WODCON XXIII.