FROM DILUTE POLYELECTROLYTE SOLUTIONS TO ENTANGLED POLYELECTROLYTE NETWORKS: A STUDY OF SODIUM CARBOXYMETHYL CELLULOSE IN WATER BY LIGHT SCATTERING AND RHEOLOGY

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Sodium carboxymethyl cellulose (Na CMC) is widely used in industry for its thickening and swelling properties. Applications are very broad and include pharmaceutical, food, home and personal care products as well as the paper industry, water treatment and mineral processing. Na CMC is a linear negatively charged water-soluble polymer derived from cellulose. Its behaviour in water is known to be very complex and a function of several parameters including the characteristics of the polymer itself [1] such as molecular weight and degree of substitution as well as the solution concentration and dissolution conditions [2] (e.g. addition order of the system components) [3]. While Dynamic Light Scattering (DLS) has been widely used to study the behaviour of polyelectrolytes, relatively few DLS studies have been conducted on Na CMC and, to our knowledge, none in pure water; this is most likely due to the difficulty of preparing salt-free Na CMC solutions of DLS grade. Indeed, the presence of even a few poorly substituted Na CMC fibres suffices to prevent proper DLS data from being collected. The aim of the present study was to investigate the behaviour of Na CMC (M_w = 700,000 g/mol; DS = 0.9) in pure water using both DLS and rheology measurements. A method was developed to prepare samples of appropriate quality for DLS measurements, which could then be successfully run over a wide range of concentrations. Rheology measurements were run in parallel to identify the different concentration regimes, facilitating comparisons to the behaviour typically found for polyelectrolytes (see Figure 1). Both DLS and rheology measurements were combined to look at the relationships between the structure of the Na CMC solutions and their rheological properties.

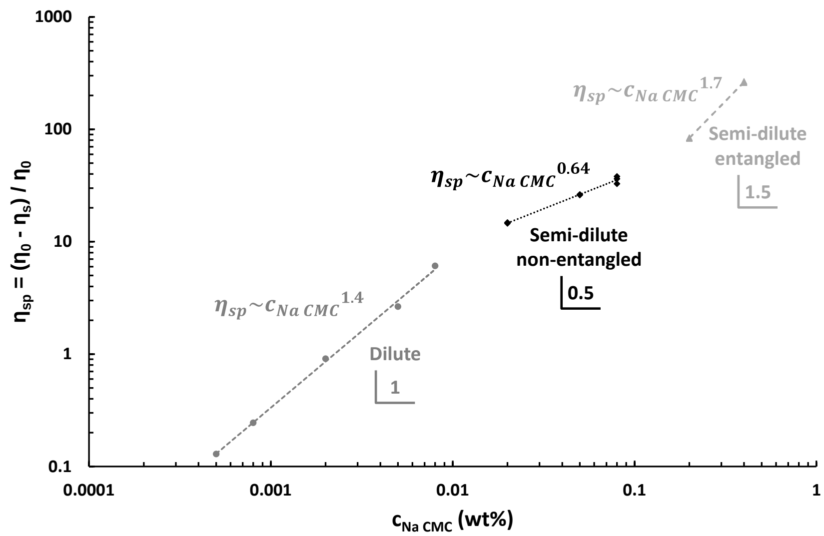

Figure 1 – Specific viscosity (η_{sp}) as a function of Na CMC concentration (completion in progress) η_0: zero-shear viscosity (obtained from the Carreau model); η_s: solvent viscosity (experimental value); the values given below the names of the different concentration regimes are the expected exponents of the power laws of the specific viscosity as a function of the polyelectrolyte concentration. Though the experimental exponents are slightly higher than the theoretical ones, they are in agreement with the literature about Na CMC [3,4].

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