

An Alternate Method of Preparing Polymer Concrete From Mixtures of Liquid and Solid Monomers

It has been reported previously¹⁻⁴ that polymer concrete (PC) composites high in strength, resistant to chemical attack, and thermally stable to 250°C can be produced. It appears technically feasible to use these materials in geothermal well completion systems and for other geothermal applications such as pipe liners. Because of their industrial and commercial possibilities, a new procedure has been derived to simplify the preparation of these PC systems.

EXPERIMENTAL RESULTS

In the monomer mixture of styrene (St), acrylonitrile (ACN), acrylamide (Aa), or methacrylamide (MAa), and trimethylolpropane trimethacrylate (TMPTMA) or divinylbenzene (DVB), it is noted that the Aa and MAa are solids at room temperature and will not readily dissolve in this group of liquids without heating. The physicochemical properties of these materials have been given earlier.¹ The monomers are heated to 45° or 50°C to dissolve the Aa or MAa, and the aggregate is also heated to these temperatures to keep the solid monomer in solution while mixing.

A new procedure is to mix the solid monomer Aa or MAa with the aggregate at room temperature, add the remaining room-temperature monomers and initiator (azobisisobutyronitrile) to this mix, and then polymerize in situ at 60°C. It appears that Aa or MAa dissolves in the liquid phase prior

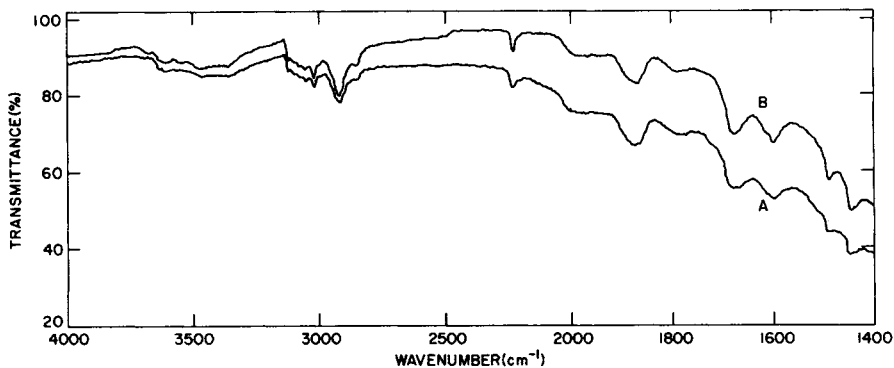


Fig. 1. Infrared absorption spectra of PC containing 11.5% polymer and 88.5% sand-cement mix (70-30%) comparing the two methods of preparation.

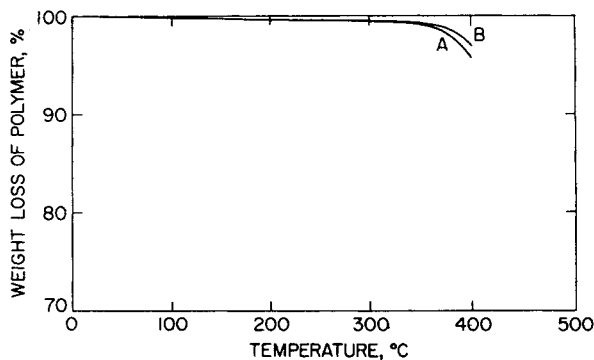


Fig. 2. TGA weight loss curve of PC containing 11.5% polymer and 88.5% sand-cement mix (70-30%) comparing the two methods of preparation.

Table I
Compression Strength After Autoclaving for 30 Days in Brine

	Compressive strength at 22°C, MPa	Compressive strength at 100°C, MPa	Compressive strength at 150°C, MPa
Hot method	237.8	192.0	162.0
Room-temperature method	222.6	200.5	186.0

to polymerization. This method produces PC as strong and durable as the PC previously reported. A comparison of the properties of the specimens was made by each of the methods.

PC samples were made using both methods (hot method and room-temperature method). The PC contained 11.5% polymer mix (50% St, 35% ACN, 5% Aa, and 10% DVB) and 88.5% aggregate (70% sand and 30% Type III portland cement).

Infrared spectra analyses were made using crushed PC in KBr pellets. As shown in Figure 1, the absorption band characteristics from samples prepared by the room-temperature method (A) and the hot method (B) are compared. The two spectra indicate the presence of all polymers in question, including the solid Aa which has been mixed with the aggregate by the room-temperature method.

Thermal analysis was performed on powdered PC which was analyzed by a du Pont 990 thermal analyzer with the 951 thermogravimetric analysis attachment at a programmed temperature rate of 10°C/min in the presence of N₂ gas. The weight loss curves (Fig. 2, where A represents the room-temperature method and B the hot method) clearly show that the PC samples are comparable to each other within 1/4% of weight loss at the temperature of 350°C.

Electron microscope study of the structure and dissolving procedure which was described earlier¹ also indicates the absence of the homopolymer phase.

For physical property measurements, 60 × 30 mm cylinders were made. These samples were autoclaved for 30 days at 240°C in 25% simulated geothermal brines. After autoclaving, the cylindrical samples were tested for compression strength at three different temperatures. The elevated compression strength samples were heated in the presence of air. Comparison of the compression strengths (see Table I) taken at 22° and 100°C for the two methods shows a 4.2% difference, which indicates comparable results.

SUMMARY AND CONCLUSIONS

This study was performed to facilitate the handling of solid monomers for commercial usage and to confirm the belief that these monomers can be incorporated into aggregates to produce high-strength, chemically resistant, and thermally stable PC. In the monomer system mentioned, the curing temperature is 60°C. Evidently at this temperature the Aa or MAa dissolves in the surrounding liquid monomer before polymerization occurs. There appears to be no segregation of constituents. However, thorough mixing of the solid monomer is essential for a good particle distribution, otherwise the desired ratio of monomers to form complete copolymers will not be achieved.

It can be seen in the thermal analysis, and physical properties, that both hot and room-temperature methods of preparation can be used to produce the same product.

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References

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