

# Scale-up to Production: Technical Note

## AM Technology

AM Technology was founded in 2000. The company specialises in innovative continuous flow reactor solutions for the chemical and pharmaceutical industries.

## Scale-up from the laboratory through to production

AM Technology offers continuous flow solutions for the scale-up of chemical processes all the way from the laboratory to production scale. This technical note introduces the range of Coflore® continuous flow reactors from AM Technology. The patented Coflore mixing technique employed within eliminates the need for rotating shafts, mechanical seals or mixing baffles.

### Coflore® ACR—Laboratory Scale

The Agitated Cell Reactor (ACR) is a laboratory-scale flow reactor based on the principle of stirred tanks in series, employing a series of dynamically mixed cells. The ACR delivers efficient mixing under plug-flow conditions for reaction times ranging from seconds up to many hours.



The Coflore® ACR continuous flow reactor

### Coflore® ATR—Pilot Plant Scale

The Agitated Tube Reactor (ATR) has been developed for higher throughputs whilst employing the same mixing technology as the smaller ACR reactor.

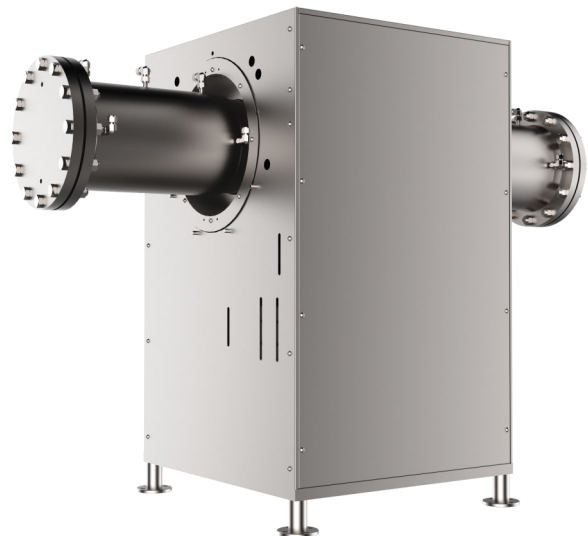


The Coflore® ATR continuous flow reactor

The reaction cells are expanded into long tubes to provide increased throughput, offering the same functional capabilities as the ACR whilst handling throughputs of up to 100 L per hour

### Coflore® RTR—Production Scale

The Rotating Tube Reactor (RTR) operates as a ten-stage, actively-mixed continuous flow reactor with a 100 L capacity that is capable of processing theoretically limitless reactor volumes without interruption.



The Coflore® RTR continuous flow reactor



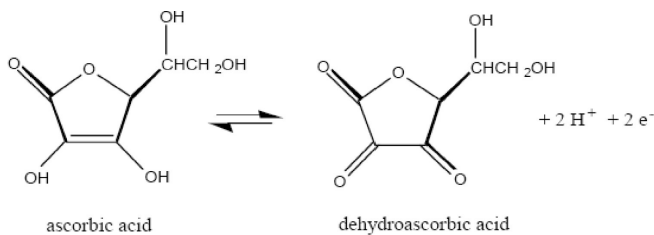
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## Scale-up test for performance comparison of Coflore® ACR, ATR & RTR flow reactors

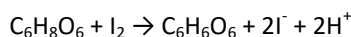
In order to determine the scalability of a particular chemical process between the Coflore® reactors, an experiment involving the heat degradation of ascorbic acid to dehydroascorbic acid was used. The performance of any given reactor is largely determined by its mixing and heat-transfer capabilities, and the ascorbic acid degradation experiment was deemed a simple and effective means of comparison. The results of such an experiment are used to assess the efficacy in scaling up a chemical process from the laboratory to production scale using the Coflore® range of flow reactors.

Ascorbic acid degradation occurs in the presence of oxygen as temperature increases, and is a sensitive enough process to allow a good performance comparison between different sized flow reactors.

Ascorbic acid is converted to dehydroascorbic acid as follows:

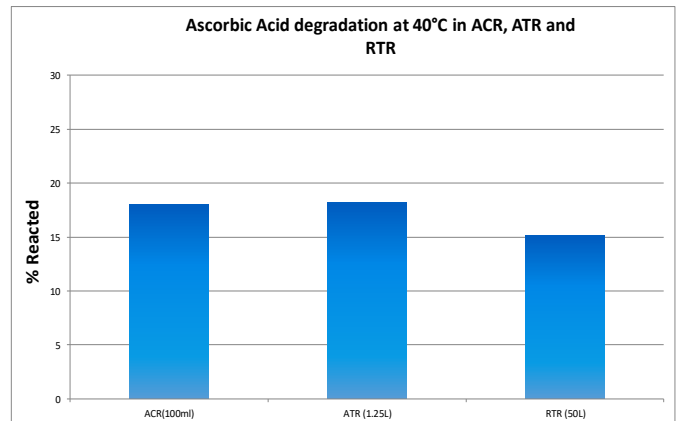


Ascorbic acid solution was fed into each reactor at 40 °C and 60 °C and continuously stirred over 3 hours. The resultant mixture was titrated against iodine to determine the amount of ascorbic acid that had degraded during the reaction:

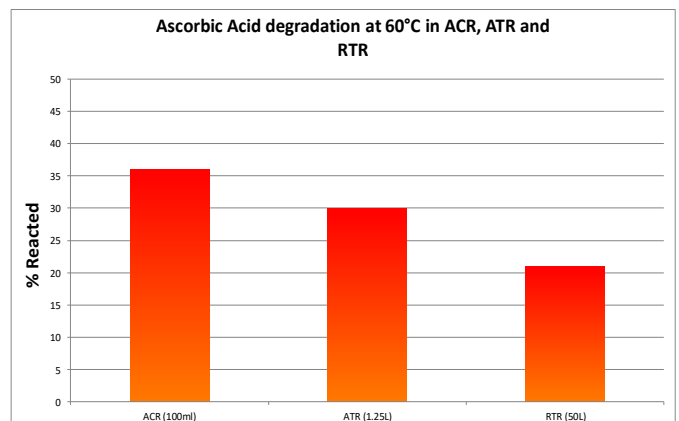


## Results

The results are given in **Figures 1 & 2** and **Table 1**, below:



**Figure 1: % reacted ascorbic acid at 40 °C**



**Figure 2: % reacted ascorbic acid at 60 °C**

Temp °C	ACR(100 ml)	ATR (1.25 L)	RTR (50 L)
60	36%	30%	21%
40	18%	18%	15%

**Table 1: % reacted ascorbic acid**

## Conclusions

The results show that despite a 500-fold increase in reactor volume from the ACR to the RTR, very similar results were observed for all three scales: lab, pilot and production, proving the efficacy in scalability for the range of Coflore® reactors

