A strategy to regulate unstable processes using a modified Smith predictor based sliding mode controller (SP-SMC) is illustrated. The proposed scheme presents disturbance rejection and optimal control input usage with overall improved regulatory Performances. The unstable process with time delay is first estimated using a simple measurement of limit cycle output obtained from a modified relay experiment. Then this paper extends a work on SP-SMC for unstable processes, which leads to significant improvements in its regulatory capacities of reference inputs and disturbances. A new control law is incorporated in the discontinuous part of sliding mode control such that the overall performance improves significantly. The metaheuristic search algorithm with some modifications has been implemented successfully to satisfy the new control performance index. The robustness of the controller is also tested under the process uncertainty. Illustrative examples show the simplicity and superiority of the presented design method over previously published approaches.