**Appendix A**

Table A1

The IPC code of fossil energy technology

| Patent type | Description | IPC Code  |
| --- | --- | --- |
| Coal | Production of fuel gases by carbureting air or other gases without pyrolysis | C10J |
| Engines | Steam engine plants; steam accumulators; engine plants not otherwise provided for; engines using special working fluids or cycles | F01K |
| Turbines | Gas-turbine plants; air intakes for jet-propulsion plants; controlling fuel supply in air-breathing jet-propulsion plants | F02C |
| Hot gas | Hot-gas or combustion-product positive-displacement engine; Use of waste heat of combustion engines, not otherwise provided for | F02G |
| Steam | Steam generation | F22 |
| Burners | Combustion apparatus; combustion processes | F23 |
| Furnaces | Furnaces; kilns; ovens; retorts | F27 |
| Fluidized bed combustion Description | Chemical or physical processes in general, conducted in the presence of fluids and solid particles; apparatus for such processes; with liquid as the fluidizing medium | B01J 8/20,22 |
| Chemical or physical processes in general, conducted in the presence of fluids and solid particles; apparatus for such processes; according to the “fluidized-bed” technique | B01J 8/24-30 |
| Ignition | Engines characterized by fuel-air mixture compression ignition | F02B 1/12,14 |
| Engines characterized by air compression and subsequent fuel addition; with compression ignition | F02B 3/06,08,10 |
| Engines characterized by the fuel-air charge being ignited by compression ignition of an additional fuel | F02B 7 |
| Engines characterized by both fuel-air mixture compression and air compression, or characterized by both positive ignition and compression ignition, e.g., in different cylinders | F02B 11 |
| Engines characterized by the introduction of liquid fuel into cylinders by use of auxiliary fluid; Compression ignition engines using air or gas for blowing fuel into compressed air in cylinder | F02B 13/02,04 |
| Methods of operating air-compressing compression-ignition engines involving introduction of small quantities of fuel in the form of a fine mist into the air in the engine's intake | F02B 49 |

As shown in Table A1, fossil energy mainly involves coal, oil, and gas. Thus, the IPC code of fossil energy technology, we refer to the research of Yang et al. (2019), Cho and Sohn (2018), and Noailly and Smeets (2015).