Inductive heating of exhaust system

During the combustion process in diesel powered internal combustion engines the fuel is ignited by the high temperature caused when the fuel and air mixture is being compressed. The high temperature and high pressure are conditions which favour the the formation of NO_x. In Europe, heavy duty diesel engines follow emission standards known as Euro I to Euro VI. Since Euro I was introduced the allowed emission of NO_x has kept decreasing.

The NO_x emissions of diesel engines are normally taken care of through a process which uses the high temperatures of the exhaust gases together with AdBlue, containing urea, sprayed upon a mixer placed inside the exhaust pipes to chemically react with the NO_x over a SCR (Selective Catalytic Reaction) catalyst. For this reaction to occur though, the exhausts of the engine need to reach about 200°C or above which normally isn't much of a problem since trucks are often run at extended periods of time and rarely have to perform cold starts where the temperature of the exhausts isn't high enough. With hybrid drive-trains increasing in popularity and their inherent increased frequency of cold starts, due to switching between electric- and combustion engine in order to work at maximum efficiency, the NO_x treatment at cold starts has become a problem that needs to be solved.

In order to allow the SCR to work even during cold starts the exhausts can be heated by the use of induction heating before or at the catalyst. This is achieved by placing windings that conducts rapidly alternating current around the exhaust pipe where the heating effect is wanted, inducing currents in conductive materials within the windings. These induced currents generate heat along the current paths they travel due to the electrical resistance of the material.

Heating the mixpipe is rather simple, but problems arise when wanting to heat the mixer instead of just the surrounding exhaust pipe. Because of the airflow through the pipe flows across the mixer, the mixer has a much better heat transfer to the air than the walls of the pipe resulting in more efficient heating. Since the exhaust pipe is made of stainless steel which is a conductive material it effectively shields everything within from the magnetic field, resulting in only the pipe getting warm.

Two solutions to this problem has been invented. One would be to cut thin slits in the pipe. By doing this it becomes much harder for the induced currents to travel within the pipe material and instead the magnetic field is able to reach the mixer, allowing for power to be induced in the mixer. This gives a much more efficient heating of the exhausts and could be the solution to quickly heat the exhausts to the required 200°C.
The other possible solution to the problem is to remove the wall of the pipe surrounding the mixer and simply create a new wall using the the tightly wound windings. Although harder to design it presents advantages such as no heating loss in the wall, and it also places the windings closer to the mixer. The smaller distance between mixer and windings gives a better inductive coupling, resulting in a more efficient heating.
Either of these solutions could be the answer to the problem and could result in more environmentally friendly trucks in the future.

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