Velox, TU Delft’s super-fast bicycle

Nevada desert, 15 September 2011

A small dot appears on the long straight road and rapidly approaches in a matter of seconds before racing by, emitting a noise like that of a passing jet aircraft. This was Sebastiaan Bowier, clocking up a speed of 129.61 km/hour during the World Human Powered Speed Challenge held at the aptly named, Battle Mountain. This was the climax of a year-long process that saw 15 TU Delft students, together forming the Human Power team, designing, building and testing a covered recumbent bicycle, the Velox. By using wind tunnel tests and advanced computer programs, they aimed to minimise their bike’s wind resistance and bid for the world record, held by a Canadian, Sam Whitingham, riding the Varna Tempsten. Bowier and the Velox remained ahead of the other teams during the race, including Whitingham, but his record of 133.27 km/hour, set in 2009, was not to be surpassed. The Human Power team returned to Delft at the end of September, but even before they got back, new ideas were already being voiced as to how they might improve their speed next year. A second team is now making preparations to that end. But let us first take a close look at the world’s fastest bicycle for this year.

Unfavourable weather conditions

Each of the teams cycled in succession, after which the results were compared. The weather conditions, which were constantly changing, had a significant potential effect on the results. For example, there is greater wind resistance when the outside temperature drops (because air humidity rises), while cold weather makes the tyres less elastic, causing an increase in rolling resistance. During the hour-long trial, the power needed for the hour-long test and top speed was measured (on the crankshaft) during the race. The power supplied by the cyclist is continuously measured (on the crankshaft) during the race. The coach in the support vehicle gives the cyclist instructions on how to achieve the optimum result.

Winfactor 1

During the design phase, a great deal of attention was paid to the shape of the Velox’s cabin. The optimised aerodynamic form was actually the starting point for the design of the rest of the bicycle, with the bicycle required to fit the cabin. But care was taken to ensure that enough space remained for the pedalling movement. The rear wheel was enclosed by a carbon fibre cover to reduce wind resistance. Without a cover, all the air in the cabin would have to be moved around. After all, the air around the wheel has to move in the same way as the wheel. No cover has been fitted around the front wheel due to lack of space: the wheel must be able to turn to the left and right.

Winfactor 2

With most other teams, it was the designers themselves who rode their own bicycles, but the team from TU Delft conducted an extensive selection procedure to find the best cyclist. Dozens of candidates were tested to see if they could deliver the power needed for the hour-long test and the sprint. They then spent six months practising for four hours a week on a recumbent or training bike. Only those not affected by claustrophobia were suitable.

Top speed

Racing bikes can reach a top speed of around 50 km/hour. The recumbent bicycle cabin reduces wind resistance to 0.1, allowing it to attain a top speed of about 130 km/h. At this speed, the motion made by the legs and feet is the same as with a racing bike, which means the sprocket wheel on the axis of the wheel being pedalled must be more than 2.5 times larger than that on a racing bike (104 teeth, instead of 42). The transmission from the sprocket wheel to the derailleur to the wheel occurs in two stages. To the rider, the lightest gear on the recumbent bicycle feels the same as the heaviest gear on a racing bike.

Limited steering

There is not much room in the cabin to turn the front wheel (no more than five degrees either way), which means the bike can only take wide turns. However, this is perfectly adequate for making a rapid sprint on the straight roads of the Nevada desert.

Disc brake

When the cyclist squeezes the handbrake, two brake pads press against the inside of a special disc brake, causing the bicycle to stop.