

## **Aeroacoustic Investigation and Improvement of a Vacuum Cleaner**

A vacuum cleaner of TÜRK-ELEKTRİK-ENDÜSTRİSİ, Istanbul, is being investigated from aerodynamic and acoustic point of view. Improvements were carried out to achieve a more efficient but less noisy machine.

The focus of this investigation was the direct comparison of the original vacuum cleaner, including its blower, with modified machines. Hence, the measurement of the absolute values of the sound power level was not the interest of the current investigation. To find a systematic way to compare machines with different operating characteristics to each other was the major difficulty of the evaluation. In detail, the design of the impeller casing and an inlet nozzle of the centrifugal flow machine have been changed.

A comparison of the blower performance at proper operating conditions of the commercial vacuum cleaner was carried out. The point of maximum efficiency and an operating point right and left of this point were taken into account. The comparison of different motor casings with different numbers of outlet guide vanes has resulted in an aerodynamic improvement associated by a rise of the noise emission of up to 3 dB. The installation of the modified motor unit in the vacuum cleaner has shown any differences in aerodynamic and acoustic performance.

Improvements of the impeller casing at the inlet region have resulted in a 4 dB reduction of the sound pressure level. Taking the amendment of the aerodynamics of the centrifugal flow machine into account a 6 dB reduction of the specific sound power level has been achieved. An additional design modification of the inlet nozzle resulted in an increase of the pressure rise up to 50 % associated with a reduction of the specific sound power level up to 7,5 dB. The noise reduction has broadband character in the frequency range between 300 and 3500 Hz. This could be explained by a reduction of flow separation in the impeller due to the improvements of the inlet flow conditions.

The benefit of the modified blower to the original one allows three possibilities to run the vacuum cleaner in future:

- First possibility is to run the vacuum cleaner on its maximally total pressure rise which was achieved with the modification of the motor casing and with the installation of an inlet nozzle.
- The second possibility is to run the vacuum cleaner with the modified blower at identical aerodynamic power of the original machine but with reduced speed. This reduction of aerodynamic power would not result in that noise reduction which is expected in the ordinary.
- With the intention of a most silent machine the third possibility is to run the vacuum cleaner with the modified blower at an identical flow rate of the original machine which results in a 26 % larger pressure rise.

Further investigations should be concentrated on the design of the inlet nozzle at the centrifugal fan casing. Additionally, modifications of the volute casing design and the outlet guide vanes should be evaluated.

## **Bir elektrikli süpürge nin aeroakustik araştırılması ve tashih edili si**

Bu projede TEE firmasının ürettiği elektrikli süpürgesi aerodinamik ve akustik olarak incelenmiş ve tashih edilmiştir. Burada yapılan ölçmeler makinaları karsilastirmak için yapılmıştır bu yüzden makinanın mutlak ölçme degerleri (absolute values) incelenmemiştir. Ventilator de ventilator kapagi degistirilmis ve bir de ventilatorün hava girisine difüzör eklenmiştir. Ventilator kapaginin degistirilmesiyle süpürge nin ses basincinda (sound pressure) 4dB ve ses gücünde (sound power) 6dB' ye varan azalma kayd edilmiştir. Difüzör de eklenince makinanın toplam basinc yükselisi (total pressure increase) 50%' ye cikmiştir ve bununla beraber makinanın ses gücü (sound power) 7,5dB düşmüştür.

Objektiv karsilastirmalar yapılabilmesi için karsilastirmalar orijinal süpürge nin üç ayirici calisma noktasinda (working points) gerçekleştirilmiştir. Bunlardan biri süpürge nin en iyi calistigi nokta (best working point) ve diger ikisinde en iyi noktanin saginda ve solunda bulunmaktadır. Motor kapaklarinin karsilastirilmasinda sekiz kanatli motor kapaginin aerodinamik olarak iyi ama akustik olarak kötü oldugu sonucuna varılmıştır. Süpürge nin en iyi calisma noktasinda (best working point) sekiz kanatli motor kapagi ses basincinda (sound pressure) diger kapaklara nazaren 3dB sesli cikmiştir. Motor kapaklari yeni ventilator kapagiyla kullanildiginda motor kapaklari arasinda hic bir farklılik gözetiilmemmiştir.

Yeni ventilator kapagi ve difüzör ile ortaya cikan yeni süpürge nin hem aerodinamik hem de akustik olarak orijinal süpürge den büyük üstünlük göstermesi gelecekte süpürge nin kullanimi için üç olanak ortaya cikarmıştır:

- -Birinci olanak yeni süpürge yi en yüksek toplam basinc yükselisiyle (total pressure increase) kullanmak.
- -Ikinci olanak yeni süpürge yi orijinal süpürge nin aerodinamik gücüyle kullanmak. Yeni süpürge nin aerodinamik gücünün düşürülmesiyle beraber beklenenin tersine süpürge nin akustik degerlerinde bir degisiklik kayd edilmiyor.
- -Üçüncü olanak ise eger birinci sirada sirf akustige önem veriliyorsa süpürge yi yeni ventilator kapagiyla kullanmak. Çünkü gürültü azalması yeni ventilator kapagiyla elde edilmiştir. Bunun yanında birde orijinal süpürge ye nazaren toplam basinc yükselisinde (total pressure increase) 26% oraninda bir yükselis kayd edilmiştir.