0.338 Mpa 时才作出反应（关闭电磁阀或电磁阀放气)，采用单电磁阀进行伺服控制的第二组在第 700 ms 将气压稳定到了 0.3 Mpa。而采用 PPM 双电磁阀控制的组，在第 625 ms 就达到了气压峰值（0.318 Mpa)，并随之执行比例控制程序，最终在第 675ms 时将气缸内气压稳定在了 0.3 Mpa。比采用单电磁阀控制的系统的延迟低 25ms

由实验数据可以得到一下结论：

（1）采用 PPM 双电磁阀和比例控制方法结合进行气动控制时，可以将系统的延迟降低约 25 ms。可以实现更灵敏的控制。

（2）采用 PPM 双电磁阀进行气动控制时，可以降低由于系统延迟导致的气压峰值，保护系统安全。

（3）本实验从理论证明采用 PPM 双电磁阀进行气动控制可行。后续可以利用更多方法控制相位（比如 PID），通过调节参数，延迟可以进一步降低，实现更加精确的控制。

UDC 622.658.345

JUSTIFICATION OF PARAMETERS OF WHEEL PRPOLLER WITH PIVOT AXLE OF SELF-PROPELLED MINE CARS

Stain A. I., Drozdovich Z. S.
Scientific Supervisor Basalai R. A.
Belarusian National Technical University
e-mail: rbasalai@bntu.by

Summary. *The analysis of the efficiency of work of self-propelled mine cars as part of tunneling complexes is carried out. Perspective schemes of power supply of self-propelled mine cars, as well as ways of modernizing their wheel propellers are considered. The calculation of the parameters of the wheel propeller control system during the maneuvering of a self-propelled mine car is performed.*

Tunneling complexes are used at the sheet deposits that are developed by the shaft method. The efficiency of tunneling complexes largely depends on the productivity of self-propelled mine cars (SHSV), which is determined by their design parameters. They are incorporated in the general layout of the machine, in the design features of the wheel propeller and the moving bottom of the bunker, in the energy potential of electric motors and their power supply system, the type of actuator drives, control and diagnostic systems.

The parameters of the SHSV mentioned above are laid down at the design stage, taking into account the mining and geological features of the deposit, technological schemes for the development of mineral layers, as well as with maximum optimization in terms of design and operational parameters with tunneling machines and equipment at points of rock transfer to the main conveyor transport. The analysis shows that the capacity of the bunker, the power supply system of the SHSV, as well as the length of the route along the underground working from the shearer in the face to the point of rock unloading, have the main influence on the productivity of the tunneling complex. Therefore, an urgent task remains to increase the efficiency of the SHSV, in particular, the modernization of the wheeled propellers of the SHSV. Wheel propellers of the SHSV, depending on the technological operating conditions and the specified load capacity, are made according to several design schemes. The most common are two- and three-axle schemes of wheel propellers of the SHSV. The limiting factor in the layout of the propeller of the machine is the carrying capacity and dimensions of the tires.

Two-axle propellers with all-drive and steerex wheels are distinguished by the minimum turning radius of the machines, which is very important in conditions of limited transverse dimensions and curvature of mine roadways. The carrying capacity of these SHSV is 15−25 tons. Three-axle propellers, as a rule, with steered wheels of one axle are used on SHSV with a carrying capacity of 30 tons or more for operation in wide underground mine workings, since they have lower maneuverability. All-wheel drive two- or three-axle wheel propellers with an articulated frame are widely used in underground LHDs, which provide them with high maneuverability. The application of these schemes on SHSV is limited by the design parameters of the bunker with a moving bottom in the form of a double-chain scraper conveyor.

The scheme of a two-axle propeller SHSV with rotary axes and motor-wheels seems promis ing for the des ign s tudy.

УДК 621.9.02

СТРУКТУРНАЯ МОДЕЛЬ И РАСЧЕТ ПОКАЗАТЕЛЕЙ НАДЕЖНОСТИ СБОРНЫХ ТОРЦОВЫХ ФРЕЗ

Ажар А. В., Верхотуров А. Д.
Белорусский национальный технический университет
e-mail: azhar.a@bntu.by

Summary. *The cutter body and the insert holding mechanism are highly reliable elements that have a probability of failure-free operation close to unity in the period of time before the tool stops. The reliability of the cutter is assessed by the reliability of its inserts (cutting part), which often fail due to breakages and chipping. The assembled face milling cutter has a reliability model of a parallel-serial type with a constant loaded reserve caused by the constructive redundancy of the tool. The cutter performance criterion is the load capacity of the plate (tooth), determined by the "breaking" feed. Models of reliability and examples of evaluating the reliability of face mills with the number of teeth z = 6 at various tool feeds are presented. The calculation of the reliability of the tool was made using a logical-probabilistic method. It was found that there is an extreme (optimal) feed, which determines the specified level of tool reliability as a whole, and the change in feed has a nonlinear effect on the level of reliability of face milling.*

Современные торцовые фрезы имеют блочно-модульную конструкцию с режущей частью в виде сменных неперетачиваемых пластин [1]. Анализ существующих структурных схем надежности и методов резервирования технических систем показал, что торцовая фреза − это многоэлементная система с различной степенью функциональной зависимости элементов, имеющая структуру надежности параллельно-последовательного типа с резервированием [2, 3]. Т. к. корпус фрезы и механизм крепления режущей части в некотором приближении можно отнести к высоконадежным элементам, имеющим вероятность безотказной работы P_i близкими к единице в промежутке времени до отказа инструмента, то надежность фрезы можно оценивать по надежности ее режущей части. Фрезам при непрерывной эксплуатации характерно структурное постоянное резервирование, вызванное конструктивной избыточностью инструмента в связи с возрастающими требованиями к росту производительности при обработке. Одним из условий функционирования этих инструментов является нагрузочная способность зуба, определяемая «ломающей» подачей при черновой обработке [4]. При постоянном резервировании не требуются специальные устройства, вводящие в действие резервный элемент, а также отсутствует перерыв в работе. С точки зрения режима работы резервные элементы нагружены.

Модель и метод расчета показателей надежности торцовых фрез во многом зависят от критерия отказа инструмента (поломка, предельный износ, потеря точности детали), от оцениваемого показателя надежности (безотказность работы инструмента, общий ресурс с учетом или без учета параметров восстановления работоспособности). Для примера рассчитаем вероятность безотказной работы торцовой фрезы с числом